SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, MARCH 27, 1903.

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AMERICAN SOCIETY OF ZOOLOGISTS. I.

THE American Morphological Society and the Zoologists of the Central and Western States met in Washington, D. C., in the Medical School Building of the Columbian University, December 30, 1902, and held joint sessions during this and the two succeeding days. A very large number of the members of the societies were in attendance, and an unusually long and interesting program was enjoyed.

During the meeting final action was taken that brought the members of the two above-mentioned societies together under the name of the American Society of Zoologists, with an eastern and a central branch. The constitution adopted looks toward meetings of the society once in three years, to be held alternately in the territories of the two branches. The time and place of the annual meeting of each branch is to be determined by its executive committee.

During the afternoon of the first day a joint session was held with Section F of the American Association for the Advancement of Science, at which papers from the programs of each of the societies were given. Owing to the large number of papers to be presented, further combination did not seem expedient.

The following are brief abstracts of the papers that were presented:

The Atlantic Palolo: Alfred G. Mayer, Museum of the Brooklyn Institute of Arts and Sciences.

The 'Atlantic Palolo' is *Eunice fucata* Ehlers. It is found at the Dry Tortugas, Florida, and lives within disintegrating coral rock or coquina from below low tide level to a depth of at least six fathoms. Its breeding habits are closely similar to those of the well known Pacific Palolo worm (*Eunice viridis*).

The Atlantic Palolo swarms at the surface before sunrise within three days of the day of the last quarter of the moon, between June 29 and July 28. The posterior sexually mature end of the worm breaks away from the anterior end, and swims backwards and upwards to the surface, where it continues to swim backward with great rapidity until about the time of sunrise, when it contracts, casting the genital products out into the water. The anterior part of the worm remains below in the coral rock, and takes no part in the swarm. The worm requires at least two years to attain sexual maturity. There are 57 per cent. of males and 43 per cent. of females. Only sexually mature worms cast off their posterior ends at the time of the swarm. The immature worms are about twelve times as numerous as the mature.

The shock produced by cracking the coral rock acts as a stimulus to produce the drama of the breeding-swarm before the normal date of the swarm. Eggs obtained in this manner are immature and can not be fertilized, even twelve hours before the time of the normal swarm. All of the eggs mature simultaneously within the swimming worms at the time of the normal swarm.

The eggs float in the water, are fertilized and begin to segment soon after extrusion from the worm. The segmentation is total and unequal, the gastrula is formed by epibole, and the larva is telotrochal. The young larvæ swim near the surface, but sink to the bottom upon attaining four pairs of setigerous lobes. The posterior segment of the larva bears a pair of dorsal as well as a pair of ventral cirri. Only the ventral pair of cirri persist in the fully developed worm.

An Aberrant Rotatorian: T. H. Montgomery, Jr., University of Pennsylvania. (Read by title.)

Dimorphic Queens in an American Ant (*Lasius latipes* Walsh): W. M. Wheeler and J. F. McClendon, University of Texas. (Published in the *Biological Bulletin*, Vol. IV., No. 4, March 1903, pp. 149–163, 3 Figs.)

A colony of *Lasius latipes* observed near Rockford, Illinois, during the nuptial flight (September 17, 1902) was found to contain numerous virgin queens of two different types. One of these (the 'β-female') was the fulvous red, remarkably hairy and flat-legged type, with very short tarsi, that has been heretofore regarded as *the* female of *latipes*. The other ('α-female') was dark brown, less hairy, with much less flattened legs and decidedly longer tarsi. The α-type was also found in material from two nests of *latipes* collected in a very different locality (Colebrook, Connecticut) during August, 1901. No transitions between the two types were observed in any of the nests. The following hypotheses may be advanced to account for the occurrence of the two different queens in the same colony: (1) One of these may be supposed to be the female of a species parasitic on *latipes*. (2) The β-female may represent merely a diseased condition of the α-female. (3) The α-form, in pilosity and structure, is so clearly intermediate between the β-form and the female of *Lasius claviger* Roger as to sug-

gest the possibility of its being a hybrid between *latipes* (β-female) and *claviger* ♂. (4) The α- and β-females represent a new case of dimorphism *sensu stricto* in *L. latipes*. Of these four hypotheses the first and second may be rejected as too improbable to be entertained. The true meaning of the two forms of queens is probably to be sought in the direction of hybridism or of dimorphism *sensu stricto*. Only further observation and experiment can enable us to decide between these interesting alternatives.

Septal Sequence in Corals: J. E. DUERDEN, University of North Carolina.

An account was given of the manner of appearance of the septa in the West Indian coral, *Siderastraea radians* (Pallas), the post-larval development of which has been followed for four months. The results were summarized as follows:

1. The six members of the first cycle of entosepta appear simultaneously, shortly after fixation of the larva, situated within the entocœles of the first cycle of mesenteries.

2. The members of the temporary second cycle, consisting of six exosepta, are developed shortly after the primary cycle of entosepta, within the primary exocœles. The six septa arise simultaneously, or in bilateral pairs in a dorso-ventral order. Later they become bifurcated peripherally, either by the direct extension of the original septum or by the production of separate fragments which subsequently fuse. The bifurcations also appear in a dorso-ventral order.

3. The six members of the permanent second cycle of entosepta arise within the entocœles of the second cycle mesenteries, after these have made their appearance. The two right and left dorsal septa appear first, then the two middle members, and, at a much later period, the two ventral, thus exhibiting a decided dorso-ventrality. In the end they become equal and fuse with the central parts of the second cycle of exosepta previously developed, which now lose their individuality.

4. The twelve members of the temporary third cycle are situated within the exocœles between the primary and secondary pairs of mesenteries, and represent the bifurcated extensions of the six primary exosepta. The original second cycle exosepta thus become the third exocœlic cycle, their place having been taken by the new second cycle of entosepta (law of substitution).

5. The later development of the septa in buds proves that a new third cycle of septa arises in a similar manner, on the appearance of the third cycle mesenteries. New entosepta appear within the entocœles of the third cycle mesenteries, and the bifurcations of the twelve third cycle exosepta become the twenty-four exosepta of the fourth cycle.

6. Exosepta thus appear at each stage in the growth of the corallum, alternating in position and corresponding in number with the entosepta. They never become entosepta, but always constitute the outermost cycle; only the entosepta have any ordinal significance. The adult radial symmetry of the septa is secondary, being derived from structures which appear bilaterally in a dorso-ventral order.

The various stages in development were illustrated by a series of wax models prepared at the American Museum of Natural History, New York.

Iridescent Feathers: R. M. STRONG, Haverford College.

Iridescent feathers from the sides of the neck of the common 'homer' pigeon appear green when the sum of the angles of incidence and reflection is less than 90°, and purple when the sum is more than 90° but less than 140°. The iridescence is

produced by a peculiar form of barbules. There are no attenuated portions, and the individual barbules overlay one another like shingles.

The iridescence is confined to the distal exposed portion of the feather; the same barb may have iridescent barbules distally, and non-iridescent barbules proximally.

The iridescent barbules have much more pigment than the non-iridescent, and this pigment is in the form of spherical granules of melanin, which fill cavities enclosed by a thin transparent layer of keratin. The non-iridescent barbules have the usual rod-shaped pigment granules characteristic of ordinary feathers; these are irregularly distributed in the keratin of the barbule and are often fused more or less completely into small masses.

The spherical pigment granules lying next to the transparent horn layer produce a dispersion of incident light, and the unaided eye receives a mixture of great numbers of the spectra thus formed.

On Anamniote Embryos of the Chick: Frank Rattray Lillie, Hull Zoological Laboratory of the University of Chicago.

The experiments described in this paper consisted, first, in the destruction of the head fold of the amnion between the thirty-third and forty-sixth hours of incubation, with a heated needle; second, a similar operation on the tail-fold of the amnion, immediately after its appearance. If the head fold were completely destroyed without injury to the embryo, the development might proceed up to the age of at least five days in normal manner, except for the complete absence of the amnion back to the hind limbs. In such cases the embryo lay naked on the surface of the blastoderm, to which it was attached in the same manner as a shark's embryo by a very broad somatic and splanchnic umbilicus.

The main conclusions were:

1. The lateral folds of the amnion are in part dependent on the formation of the head fold. In the absence of the latter they are neither so high nor so long as usual, and they do not grow around the embryo. The lateral folds of the amnion must have the support of the head fold to climb up, so to speak, around the body of the embryo.

2. The tail fold of the amnion has only a limited independent capacity of growth; in the absence of the head and lateral folds it does not extend even as far forward as normal.

3. Similarly the head and lateral folds of the amnion have a limited capacity for growth; their backward extension is not simply checked by the advancing tail fold; for, in the absence of the tail fold, these end with a free border in front of the hind limbs.

4. The absence of the amnion has, at least for a time, only a limited effect on the development of the allantois.

5. Inasmuch as the embryo may develop quite normally to the stage of five days without the amnion, it is obvious that the functional significance of the latter must be slight during this period. It yet remains to be determined how far the embryo may develop without the amnion. Certainly there is no good reason for assuming that five days is the limit.

6. There is a certain relation of interdependence between the formation of the amnion and the body wall. In the absence of normal formation of the lateral folds of the amnion, the closure of the somatopleure to form the body wall proceeds more slowly than usual.

The Newly Hatched Larva of Argulus megalops: Chas. B. Wilson, Westfield, Mass., State Normal School.

The most recent classification of the Copepods divides them into three classes:

A. The free-living copepods, Gnathostomata.

B. The parasitic copepods, Siphonostomata.

C. The Branchiura or Argulidæ, also parasitic.

The normal development of the copepods, viz., of the Gnathostomata, is well known to every teacher of zoology, and all have become familiar with the nauplius, metanauplius and cyclops stages in their life history. But the development of the Siphonostomata is still very imperfectly known, and while agreeing in many species with that of the free-living forms, there are frequent modifications resulting from parasitic habits.

The development of the third group, the Argulidæ, has rested until recently upon the study of a single European species, *A. foliaceus,* parasitic upon fresh-water fishes.

But the Argulidæ are found in greater abundance in North and South America and in Africa than in Europe, and are fairly well divided between fresh-water and marine forms.

A recent study of four American species shows that two of them, *A. americanus* and *A. catostomi,* the former a fresh-water species and the latter occurring in both fresh and brackish water, agree almost exactly with *A. foliaceus* in development.

But the life history of the other two species, one, *A. stizostethii,* a fresh-water form, and the other, *A. megalops,* which is marine, is quite different. In both these species the newly hatched larva is almost exactly like the adult. There is no narrowing of the body posteriorly, the abdomen being fully as wide as the thorax and of the same shape as in the adult.

The carapace is somewhat shortened, but even when fully developed it is very meager. The number and arrangement of the appendages are exactly the same as they will always continue.

The form and function of these appendages are also the same, with the single exception of the first maxillipeds, and even here, while the form changes, the function remains constant from the beginning. There is no trace of a temporary locomotor apparatus of any sort or description, as in all other copepod larvæ. We have here, therefore, practically no metamorphosis at all, but a copepod life history which is virtually a direct development, and there is a marked resemblance to the life history of certain orders amongst the insects, such as the Orthoptera, etc.

The Arrangement of the Segmental Muscles in the Geophilidæ, and its Bearing upon the Double Nature of the Segment in the Hexapoda and Chilopoda: L. B. WALTON, Kenyon College.

The arrangement of the dorsal lateral longitudinal muscles in the Geophilidæ corresponds to the division of the segment into an anterior and posterior somite. This, considered in connection with the presence of homologous areas in *Scolopendrella, Campodea, Japyx, Forficula,* etc., together with other evidence, notably the development of the pterygodum (tegula) and wing of the mesothorax in Lepidoptera, the double cross commissures in the embryonic stages of Hexapoda and Chilopoda (as well as Crustacea and Arachnida), the two pairs of metathoracic tracheal openings in *Japyx,* etc., presents a strong case for regarding the segment in the Hexapoda and Chilopoda as composed of two somites, for which the terms *protosomite* and *deutosomite* are proposed.

The 'microthorax' to which Verhoeff has recently called attention as a fourth thoracic segment anterior to the prothorax (Dermaptera) can not be homologized, as he suggests, with the segment bearing the

poison claws in Chilopoda, inasmuch as this segment is composed of a protosomite and deutosomite, the former being homologous with the microthorax (see Geophilidæ). Furthermore, a protosomite homodynamous with the 'microthorax' is present in the Dermaptera on the mesothoracic and metathoracic, as well as on the abdominal, segments. Consequently there is evidence for considering that not only is the thorax in Hexapoda composed of six somites, but that each typical segment in the Hexapoda and Chilopoda (Crustacea and Arachnida?) is composed of two coalesced somites.

The Vertebrate Stomach: J. S. Kingsley, Tufts College.

It is usually believed, since the liver in *Amphioxus* directly follows the gill slit region, that the vertebrate stomach and œsophagus were primitively included in the respiratory region. In the embryos of the vertebrates, however, the anlage of the liver follows as closely the last gill slit as it does in *Amphioxus,* and the stomach and gullet are developed, not from the pharyngeal region, but by rapid growth of the short intermediate region. Hence the stomach in the vertebrate is a new formation without its counterpart in the lower chordates.

The Occurrence of Echinoderm Larvæ with Transverse Ciliated Bands: Caswell Grave, Johns Hopkins University. (To be published in the *Biological Bulletin.*)

Serial Order of Segments in the Fore-brain of Three- and Four-week Human Embryos; Comparisons with Lower Forms: Susanna Phelps Gage, Ithaca, N. Y. (With demonstrations from a series of wax models.)

A three-week human embryo from the collection of Dr. Mall, of Johns Hopkins University, and shown by him and Dr. Bardeen to have two slight anomalies, presents, in the regions of the fore-brain in which the eye and olfactory region are well defined, a third peculiarity. The remnant of the neuropore, the original cephalic opening of the fore-brain, is unusually conspicuous and consists of a thickened union of the epithelium of skin and brain wall. Here arises a furrow extending toward each eye. The conclusion was reached that this point represents approximately the cephalic end of the original neural plate and that as a corollary, by following the original edge of the neural plate, the olfactory region is morphologically caudad of the eye.

A finely preserved and entirely normal human embryo of four weeks prepared by Dr. Buxton, of the Cornell Medical School, gives a similar model, except that the neuropore does not show a thickening. Many other mammalian brains of this stage give similar results.

In a series of chick brains the neuropore was traced to the fifth day, when it was shown to become the recessus opticus.

Summarizing the results of studies in the earlier stages of chick, *Amblystoma* and mouse—the earliest total fold or segment of the fore-brain to appear is the hypophyseal at the cephalic tip of the neural plate; with growth and curving forward of the fore-brain, the eye, second in serial order with relation to the edge of the neural plate, appears; as the eye becomes constricted off the olfactory furrow of the brain appears, entirely dorsal, as shown by His and again (with reference to the edge of the neural plate) following the eye in serial order; next comes the diencephal. From the caudal portion of this original olfactory region arise the folds characteristic of the cerebrum, and from the one furrow of the diencephal the three shown by Minot arise.

Until certain difficult homologies are made in the hypophyseal region of the

brain I hesitate to write a numerical series for the total folds or segments of the forebrain, but with regard to the crucial point in the investigation, the series and the models seem to show conclusively that the eye and its lens are morphologically cephalad of the olfactory region of the brain and of the nasal epithelium.

A Preliminary Account of Studies on the Japanese Frilled Shark, Chlamydoselachus: BASHFORD DEAN, Columbia University.

In view of the archaic features in the adult, he noted as significant in the development of this form the great depth of the zone of yolk nuclei, the absence of external gills, the more nearly terminal position of the anus, the relatively smaller size of the head, the enormous spiracular cleft and the almost typically finfold type of limb. *Chlamydoselachus* has specialized in the line of producing large eggs, the largest indeed among recent animals, ostrich hardly excepted; that it was, however, until recently an egg-depositing shark is apparent from the character of the horn-like capsule (with rudimentary tendriliform processes) which the egg still retains.

The Ependymal Grooves in the Roof of the Diencephalon of Vertebrates: PORTER EDWARD SARGENT.

A cross-section of the brain of any of the lower vertebrates in the region of the posterior commissure reveals a characteristic ependymal structure of conspicuous form and size. In general this consists of thickened and highly differentiated ependyma forming a groove in the roof of the diencephalon, extending from the posterior commissure cephalad to the ganglia habenulæ. This has been mentioned by but four writers, though it occurs in all vertebrates.

In *Petromyzon* there are two grooves located bilaterally on either side of the median plane. Posteriorly they converge and extend about the posterior commissural flexure and above it and are continued cephalad as two lateral horns of the recessus above the commissure. The specialized ependyma of the grooves is sharply marked off from the ependyma, lining the other portions of the ventricle. Nerve fibers from deep-lying cells pass between the cylindrical ependymal cells, and into the ventricular groove. Here they unite to form Reissner's fiber, the anterior divisions of which lie within the groove.

In the gnathostomes there is but one median groove. In the skates, however, the median groove bifurcates at either end, —evidence of the persistence of the bilateral condition. It is obvious that, phylogenetically, the paired grooves of cyclostomes have been crowded toward the median plane by the development of laterallying structures and fused to form the one median groove.

In ganoids, teleosts and amphibians the ependymal groove is strictly median and less conspicuous. It assumes a great variety of forms in the different subgroups. In reptiles it is much as in higher selachians, but reduced in size. In birds it is still further reduced. In mammals it has become an inconspicuous structure, which may still be recognized, however, in the thickened ependyma just cephalad of the posterior commissure.

In general this ependymal structure acts as a support for the constituent elements of the fiber of Reissner, and as an 'anchorage' for the fiber as a whole.

On the Individuality of the Maternal and Paternal Chromosomes in the Development of the Hybrid between Fundulus heteroclitus and Menidia notata: WILLIAM J. MOENKHAUS, University of Indiana.

Fundulus heteroclitus and *Menidia*

notata possess chromosomes which are sufficiently different, morphologically, to be distinguished from each other in the cells of the hybrid between the two species. The former has long, straight chromosomes; the latter short, slightly curved ones.

These two kinds of chromosomes retain their individuality during the development of the hybrids to a late cleavage stage, as far as any attempt was made to follow them. During the first two cleavages each kind remains grouped upon the spindle. During the third cleavage this grouping has largely disappeared and the two kinds of chromosomes occur mingled upon the spindle. During the later cleavage stages this bilateral distribution of the chromosomes has altogether disappeared. The two kinds, however, can readily be distinguished, but thoroughly mingled.

Homologies of Anterior Limb: THEO. GILL, Smithsonian Institution.

The homologization of the anterior member of the terrestrial vertebrates with that of fishes is a problem involving a greater diversity of interpretation than any other structure. By the early anatomists (Cuvier, Owen, Stannius) bones which are now universally regarded as parts of the shoulder girdle were designated as the humerus, radius and ulna.

It is contended that *Polypterus* gives us a key to the problem in question, as was urged by the speaker in 1872, 1878 and 1882.

The diverging branches which inclose the flat cartilage with which the actinosts or basal bones of the fin connect are homologues of the radius and ulna; the tubercular process of the coracoid cartilage with which they articulate is the representative of the humerus; the cartilage between the diverging processes is the stuff from which the carpal bones are developed; and the actinosts represent the metacarpals. The nearly similar conclusions of Emory (1887) and Pollard (1892) were much later and somewhat different.

Pollard found the humerus, radius and ulna in the same parts as the speaker. He went to an extreme, however, in the homologization of the intermediate cartilage or 'mesopterygium.' This, he thought, 'forms probably the intermedium and centralia, and the chief foramen in the ossified part represents the intercarpal foramen.'

Inasmuch as *Polypterus* is a very specialized modern form of the great crossopterygian series, and no extinct representatives of its phylum since Devonian times have been discovered, such an extension of homologies is not legitimate and we must be content to recognize the 'mesopterygium,' as a whole, to be homologous with the carpus. This is in accord with the most recent investigations, but still must be confirmed by paleontology.

Homologies of the Centronucleus: GARY N. CALKINS, Columbia University.

The Structure of the Ostracoderms: W. PATTEN, Dartmouth College.

1. In a newly acquired specimen of *Trematapis* the post-orbital and the two pairs of marginal openings are completely closed by a small number of close-fitting polygonal plates. In *Cephalaspis* a single pair of very large marginal openings, closed in a similar manner, has been found. A large marginal opening has also been found in *Thyestes.*

2. In the same specimen of *Trematapis* the dumb-bell-shaped orbital opening is closed by a polished layer of shell, continuous with that of the dorsal shield. Over the lateral ends of the opening the shell is partly broken, but shows clearly that it formed a complete dome-shaped cover to each eye.

3. In *Bothriolepis,* the large median or-

bital plate has a deep pineal pit in its under surface. Two other pits, shallower than the first, are symmetrically placed behind it on the under surface of the semicircular post-orbital plate.

4. The lateral eyes in *Bothriolepis* were placed on short stalks attached to the margin of the orbits by flexible membranes. The lateral end of each stalk was convex, covered with a smooth shell, and could evidently be raised above the orbit or lowered into it.

5. The structure and relations of the 'mental plates' of *Bothriolepis* show that they can not be regarded as either upper or lower jaws of the vertebrate type. If movable at all, they must have moved to and from the median line, bringing their *thickened* and *bent-over* median edges into opposition, like the crushing mandibles of an arthropod.

6. The mouth was very small, round or oval (not a wide transverse opening), located between or just behind the mental plates.

7. The so-called 'semilunars' consist of at least three pieces. Their shape and articulating surfaces show that their posterior margins were freely movable in a *dorso-ventral* direction, like an operculum.

8. Two plates were found supposed to be, one the distal joint, the other a basal plate, of the proximal joint of the pectoral appendage of *Trematapis*.

9. The basal joint of the appendage in *Bothriolepis* contains a short axial skeleton whose expanded distal end shows indications of several fin-like rays.

10. The gill chamber of *Bothriolepis* is a shallow depression on the dorsal surface of the anterior ventrals.

11. In one specimen the gill chamber was partly covered by a folded membrane and it contained indications of gills. The most exposed gill was a flattened body of elongated form. It appeared to be jointed, with a single broad spur, and a fragmentary filament, near its base. The end directed toward the base of the pectoral appendage terminated in a leaf-like expansion.

These facts confirm the author's view that the Ostracoderms can not be classed with the true fishes.

Maturation Changes in the Egg of an Opisthobranch before Deposition: W. M. SMALLWOOD, Syracuse University.

(To be published in the *Bulletin* of the Museum of Comparative Zoology at Harvard College.)

Experiments on Merogony in Nemertine Eggs, with Reference to Cleavage and Localization: EDMUND B. WILSON, Columbia University.

The experiments were performed in order to examine the question of prelocalization of the factors determining the cleavage mosaic in the unsegmented egg. The nemertine egg presents features that allow of its definite orientation from the moment of discharge from the ovary. Egg fragments, obtained before formation of the polar bodies, by shaking the egg to pieces or cutting the eggs individually in various planes with the scalpel, segment exactly like entire eggs of diminished size. Whatever be the plane of section the fragments may, if not too small (one fourth the bulk of the egg or larger), give rise to closed blastulas, which may gastrulate normally and produce dwarf pilidia normal except in size. Isolated blastomeres of the two-cell stage may likewise produce perfect pilidia of half the normal size; isolated one fourth blastomeres may produce dwarf pilidia, never entirely normal, but sometimes very nearly so. In either case the isolated blastomere segments, not like a whole egg, but as if the missing portion of the egg were present. Blastulas

thus arise that are typically open on one side, or in extreme cases form curved or even nearly flat plates; but all these forms may ultimately close, gastrulate and give rise to pilidia, though those arising from the plate-forms appear to be always asymmetrical or otherwise abnormal.

These facts prove that in this egg, which shows a typical spiral mosaic-like cleavage, the form of cleavage is not essential to normal development, since the egg fragment segments as a whole, the isolated blastomere as a fraction, yet both may produce the same result. They prove, further, that the factors determining the cleavage mosaic are not definitely localized in predetermined germ areas before formation of the polar bodies, but become so localized in the period between the beginning of maturation and the completion of the first cleavage. Sections show that during this period a polarized segregation of material takes place. Comparison, especially with the segregation of material occurring at the corresponding period in the eggs of sea-urchins and mollusks, as described by Boveri, Lillie and Conklin, and with the results of Boveri's experiments, leads to the conclusion that this segregation of material is the immediate cause by which the cleavage factors are localized and the form of cleavage determined. Every differential cleavage is probably preceded by analogous segregation of cytoplasmic materials, which not only form an important factor in determining the form of cleavage, but probably are a factor in cell-specification. Cleavage thus plays an important part in differentiation and localization, not as a direct cause, but indirectly as a means of isolation of different materials. The cleavage-mosaic thus becomes a mosaic of such materials and of corresponding developmental tendencies in the individual blastomeres. This mosaic-like character is, however, not due to the preexistence of corresponding areas in the unsegmented egg, but to a progressive process that is essentially epigenetic in character. The primary egg-polarity certainly, and perhaps some other characters, such as bilaterality, preexist in the immature egg, but other cleavage factors are localized by a progressive process in which cytoplasmic movements are a leading factor.

Merogony and Regeneration in Renilla: Edmund B. Wilson, Columbia University.

1. When fertilized eggs of *Renilla* are cut into two or more fragments during the earlier period preceding cleavage, one of the fragments may develop into a dwarf embryo, segmenting at once into eight or ten blastomeres, like a whole egg of diminished size. During the later period, after division of the cleavage nucleus, two or more fragments may develop; but in this case each fragment divides into a smaller number of blastomeres than those produced by an entire egg, the total number being approximately the same as those produced by a whole egg. Cleavage in this egg therefore depends not upon the presence of a certain number of nuclei, but upon the attainment of a critical stage by some other progressive change. The egg fragment may give rise to a planula, and ultimately to a young colony, entirely normal in its structure and proportions, but of diminished size. In this way may be produced dwarf colonies down to about one fourth the bulk of the normal; but, like the full-sized colonies, they do not produce more than a single pair of buds under the conditions in the aquarium. Budding in *Renilla* is, therefore, not dependent upon the amount of material present, but is a process entirely analogous to the formation of organs in the ontogeny of a single individual.

2. As already recorded by Torrey, the young *Renilla* colony exhibits a strongly marked polarity, a new axial polyp being developed after removal of the anterior end, a new peduncle after the removal of the posterior end. After removal of the peduncle posterior to the budding zone it does not ordinarily regenerate a new axial polyp. In a few cases, however, a normal axial polyp was produced at the anterior end of a severed peduncle, and in one case this produced a symmetrical pair of buds in the same position as the primary pair of buds in the normal development. In a single instance a reversal of polarity was obtained, a severed axial polyp regenerating a similar polyp from the basal end, so that a two-headed monster was produced.

3. After oblique section through the budding zone a process of remolding takes place in such a manner as to cause one of the lateral buds to occupy the position formerly occupied by the axial polyp, while the wound entirely heals. A new axis is thus apparently established. At a later period, however, this initial remolding is overcome by a process of regeneration, a new axial polyp developing at the point corresponding to the position of the original one, so that the lateral polyp is again displaced to its original position at the side. This indicates that the persons of the colony are definitely specified and are not interchangeable.

The same result is given by operations in which the peduncle is removed, together with a single small lateral bud. In such cases the remaining bud remains entirely stationary in development, or may even disappear, while a new axial polyp of full size is regenerated from the cut surface. In one case where the lateral bud remained, a corresponding bud was formed on the opposite side so as again to produce the condition of the primitive colony with a single pair of buds.

4. These observations show that the individuality of the buds in *Renilla* has become wholly subordinated to that of the colony, which develops from the egg or regenerates lost parts in essentially the same way as an individual in the ordinary sense.

Notes on the Artificial Reversal of Asymmetry in Alpheus: EDMUND B. WILSON, Columbia University.

As Przribram has described, the removal of the large or hammer-chela in *Alpheus heterochelis* causes the remaining small chela to be transformed at the first or second moult into a hammer-chela of the large type, a chela of the small type being regenerated in place of the large one that has been removed. If after removal of the hammer-chela the nerve of the small chela be severed at the base, this transformation does not take place or is incomplete.

Comparison shows that the small chela of the female conforms closely to the early larval type, while that of the male is more modified in a direction toward the type of the hammer-chela. Since in the young larva both chelæ are alike (Brooks and Herrick) and correspond in type to the female small chela, the latter may be regarded as an embryonic type in a state of arrested development, while the male small chela represents a somewhat more advanced state. In both cases the development of the small chela is held in check by the presence of the large one, the inequality constituting an equilibrium characteristic of the species. Removal of the large chela releases the development of the small one, and at the same time reverses the asymmetry of material. Regeneration then proceeds along the same lines as in the normal development until the adult equilibrium is restored, but in a reversed condition. In this case, therefore, an appa-

rently adaptive regenerative process of high utility to the animal seems to require for its explanation, in the female at least, no special regulative factors that differ from those concerned in the normal development.

Instincts of the Lepidoptera: A. G. Mayer, Museum of the Brooklyn Institute of Arts and Sciences.

On the Color-patterns of Certain Bermuda Fishes: C. L. Bristol, New York University.

During the six seasons, June to August, the writer has collected large numbers of living fishes in Bermuda and sent them to the New York Aquarium, where they have been placed on exhibition, and has made many observations upon them in their natural surroundings and in confinement. Taken together they comprise the principal fishes of the West Indies and are fairly representative of the coral-reef fishes. The following conclusions are preliminary only, and may serve only as a starting point for more extended study.

Three factors are correlated with the habits to produce the specific appearance of the various species.

In general, (*a*) the scale of coloration is high, (*b*) the patterns range from simple to compex, and (*c*) the power to change color varies from almost *nil* to an astonishing degree.

1. *Warning Coloration.* — Fishes with high color, simple patterns and little if any color-change are inedible, *i. e.*, disagreeable, or are covered with harsh scales and have sharp fin rays. *E. g.*, the green parrot fish, the squirrel.

2. *Protective Coloration.*—The scale of coloration is not so high; the pattern is complex and the color-change is great. *E. g.*, the 'four-eyed' fish (*Chætodon*), the blue parrot, the hind.

3. Midway between these is a third group in which the three factors are more nearly balanced between the two extremes and in which some offensive or defensive device is added. The color is medium, the pattern is not complex and the range of color change is less than in the second group. This group is illustrated by the angel fish and the surgeons.

Lymphatics of the Lung of Necturus: W. S. Miller.

The Brain of the Larva of Echinus esculentus: E. W. MacBride, McGill University.

In larvæ of the common British sea-urchin, *Echinus esculentus,* about the twenty-first day after fertilization, there is visible at the extreme front end of the body a shallow pit lined by ectoderm cells which are thicker than those covering the general surface. When sections are made through the pit and examined with a Zeiss apochromatic immersion lens, a very thin layer of nervous fibrils is seen lying at the base of the thickened ectoderm cells. These fibrils are proved to be nervous by the exact similarity in appearance and reaction to osmic acid, between them and the first fibrils which appear in the rudiment of the adult nervous system. The pit does not form a part of the longitudinal ciliated band, and hence can not be compared to the apical thickening observed by Théel* in the larvæ of *Echinocyamus pusillus,* which becomes incorporated with the ciliated band. It does, however, correspond exactly in position with the thickening described by Field† in the larva of *Asterias vulgaris,* and with the apical plate of neuro-epithelium which is one of the character-

* Théel, 'The Development of Echinocyamus pusillus,' *Proc. Royal Soc. Upsala,* 1892.

† Field, 'The Larva of Asterias vulgaris,' *Quart. Journ. Micr. Sc.,* 1891.

istics of the *Tornaria* larva. Field was not able to detect any fibrils associated with the thickening in the larvæ he examined, but in the larva of *Echinus esculentus* the layer of fibrils above described goes on increasing in thickness as growth proceeds, until just before the metamorphosis it is as thick as the cells themselves, and intermixed with the fibrils are a few minute ganglion cells of the type commonly found in the nervous system of echinoderma. The discovery of this brain removes a great difficulty in the way of comparing the larvæ of echinoderma with the *Tornaria* larva.

The Effect of Lithium Chloride on the Development of the Frog's Egg: T. H. MORGAN, Bryn Mawr College.

In 1894 I tried the effect of several solutions on the development of the frog's egg; amongst others, solutions of several halogen salts. The main result was to produce spina bifida embryos. A year later Hertwig extended the same experiment, and in 1896 Gurwitsch also described the effect of a number of substances, including lithium chloride, on the development of the frog's egg. The interpretation given by Gurwitsch of the kind of embryos produced by solutions of this salt did not appear to me to fit in with results that I had obtained in other ways. This led me to take up the subject again. Amongst the different kinds of embryos that I obtained there were some similar to those described by Gurwitsch. I shall not, however, describe here embryos of this sort, nor discuss their interpretation.* Amongst the embryos there was a characteristic kind, different from any that have been yet obtained. It is these that I shall now describe.

* Madame Rondeau-Luzeau has more recently (1902) described the effect of lithium chloride on the frog's egg.

Eggs in the two- and four-cell stages, as well as in early and later segmentation stages, were put into fresh water to which 0.4, 0.5, 0.6 per cent. lithium chloride had been added. The best results were obtained from eggs in the late segmentation stages.

There appears after several days in the eggs in the solutions an invagination on one side of the egg. A little later a crescentic depression or even a complete ring appears high up on the egg, and the whole black hemisphere seems to be sinking into the interior of the egg, with the crescent or ring closing over the top of the egg. At the same time a slate-colored band appears in the region between the first invagination and the ring above. This band is much broader on that side of the egg where the invagination first appeared. Along the middle of this area a darker line runs vertically upward. I may say at once that this line indicates the position of the notochord, and the slate-colored band is a layer of endoderm cells, one cell deep. Beneath it are the two mesoblastic sheets, one on each side of the notochord.

Sections of these eggs show clearly what has taken place. The top of the egg that disappeared into the interior forms inside of the egg the medullary plate, bent double on itself. It lies, therefore, in the middle of the egg. As the whole ectoderm has turned in, the yolk-cells from the sides have been drawn upward, where they form the single layer of cells that cover the slate-colored area. Beneath this lies on each side of the notochord a thick mesoblastic sheet.

The first invagination (archenteron) sinks deep into the egg—possibly it is continued by the yolk cells drawing apart. A narrow archenteron is formed in this way, that bends under the medullary plate in the interior of the egg. The notochord,

that lies just below the dark groove in the middle of the slate-colored area continues into the egg along the dorsal wall of the archenteron.

These embryos do not appear to be able to develop much beyond this stage, although they may remain alive for several days longer in the solutions. The interpretation of this peculiar method of development seems to be as follows: The cells of the upper hemisphere appear to have been prevented from growing down at the sides, and, after the blastopore has been formed, from covering over the lower hemisphere. The medullary plate develops from the inner wall of the cap of ectoderm that has been turned into the interior of the egg. As this upper region sinks in, the surface yolk cells below the equator of the egg are drawn upwards, as has been said, and produce the slate-colored band. They may be supposed to represent, in a general way, the dorsal wall of the archenteron of the normal egg, which is now spread out on the surface of the egg. This comparison needs, however, several important limitations, which I can not enter into here. The rest of the archenteron is represented by the long but very narrow tube leading inwards from the blastopore. Thus the embryo is, in a sense, inverted, the nervous system being in the interior of the egg, and yolk cells almost completely covering the surface. The result is due in all probability, in part, to changes in the osmotic conditions in the egg. I hope soon to describe, with figures, these embryos, as well as other kinds produced in the same solutions.

Experiments on the Origin of the Cleavage Centrosomes: E. G. Conklin, University of Pennsylvania. (To be published in the *Biological Bulletin.*)

On the Erosion of the Shell of Littorina litorea: R. P. Bigelow and Eleanor P. Rathbun.

The investigations of Morse and Ganong have shown that *Littorina litorea* has become established on our coast within the last half century, and Bumpus has made a statistical study of the species, from which important conclusions were drawn as to the changes of type and variability resulting from this change of environment.

Therefore, this species seemed to be a favorable one upon which to make a determination of the present rate and direction of natural selection. But it seemed wise to determine first how far erosion might tend to falsify the results.

Sections of fresh shells were made by the method used in sectioning minerals, and the chief results are given in the following table.

Stage.	Length of Shell.	Estimated Reduction.			Increase of Ventricosity.
	mm.	mm	Per. cent. of total length.	Per cent of stage 1.	Per. cent. of total length.
1.	2.87	0	0	0	0
2.	5.0	0.25	5.0	8.7	—
3.	12.5	0.6	4.8	20.9	4
4.	17.0	1.33	7.8	46.3	5–6

The section shows that erosion has begun in stage 1, but, as that is the smallest shell that it was possible to cut, the erosion is assumed to be zero for purpose of comparison with the later stages.

These observations are not sufficiently numerous to have a statistical value, but they are sufficient to show that the factor of erosion must be considered before any conclusions can be drawn from a statistical study of the dimensions of shells of this species, and to suggest that it would be well to make sections and study carefully the extent of erosion before publishing the results of measurements of any other gasteropod shell.

The Variations of Some Acquired Characters: R. P. BIGELOW and ELEANOR P. RATHBUN.

The discussion of the phenomena of co-adaptation has emphasized the view that success of the individual in the struggle for existence may depend as much upon favorable individually acquired modifications as upon congenital variations. The present state of any species, then, is the result of selection acting on both (1) variations and (2) modifications, tending to eliminate the unfit of both indiscriminately, and to spare the best fitted. In order to understand the effect of this process upon the species as a whole it is necessary to know the types and the distributions of the deviations of the selected characters.

Much has been done to supply data in regard to congenital variations by workers following the methods perfected by Pearson. But heretofore this new means of investigating biological phenomena has not been employed in the study of acquired modifications. The present investigation was undertaken as a preliminary reconnaissance of this new field.

The material chosen for study is obtained from the records of the first-year students of the Boston Normal School of Gymnastics, kindly furnished to the authors by the director, Miss Amy M. Homans. The records selected are those of women who have completed the first year of training and whose measurements have been recorded at the beginning of the year and at the end of the eight months. The average age is 23.6 years, but nearly half of the students are between 19 and 22 years of age. In most of the series of measurements we were able to obtain from 300 to 330 individual records. The students come from various parts of the country, and upon entering the school are introduced into a new environment, which is very uniform, the gymnastic and mental training being the same for all students.

The questions that the authors have sought to answer are: (1) Is there a change of type, and of what extent? (2) What is the effect of training upon the variability of the group? (3) What is the relation between capacity for modification and initial position in the scale? and (4) what relation exists between amount of modification and length of time of training? The first question has already been answered partially by Beyer, Enebuske, and Wood; the others have not been answered before.

Five series of measurements have been studied, viz., (1) girth of left forearm, (2) lung capacity, (3) mobility of chest, *i. e.*, difference between girth at rest and girth at forced inspiration, (4) strength-weight index, *i. e.*, all the strength tests added together and divided by the weight, and (5) strength of legs.

As was to be expected, the value of the mean of each of these characters was found to have become greater after training. The difference is best expressed in terms of the initial standard deviation. The smallest change was in the girth of the left forearm, amounting to 22.6 per cent. of the standard deviation; the greatest was in the strength of legs, 162.5 per cent. The other changes of type were: lung capacity, 40 per cent.; mobility of chest, 55.5 per cent., and strength-weight index, 101.2 per cent.

The variability was found not to have changed to a sensible degree in three of the series, while in two others there was an increase. For the strength-weight index this was 11.25 per cent. of the original standard deviation, and for the strength of legs, 18.33 per cent. It will be noticed that these two series are the same ones in which the increase of the mean exceeds the magnitude of the standard deviation. The frequency curves are all slightly skew at

first in a positive direction, and after training show a little increase of positive asymmetry, with the exception of the strength-weight index, in which the skewness decreases to nearly perfect symmetry.

The relation between capacity for modification and the initial position in the scale can be determined only after calculation of coefficients of correlation, and for this purpose correlation tables are now being constructed.

The relation between the amount of modification and the length of time of training has been studied in only one series of measurements, that of the strength of legs. The measurements were plotted for every second month, that is, October, December, February, April and June. The magnitude of the mean was found to increase during each succeeding period, rapidly at first and then more and more slowly. The increase amounted during the first period to 20 kilos, during the second to 8.8 kilos, third to 6.4 kilos, and fourth to 0.37 kilos.

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*SOME FUNDAMENTAL DISCOVERIES IN MATHEMATICS.**

The oldest extensive work on mathematics which has been deciphered was written by an Egyptian named Ahmes between 1700 and 2000 B.C. It bears the following title: 'Direction for obtaining a knowledge of all dark things * * * all secrets which are contained in the things,' and claims to be modeled after writings which were then old. The first part is devoted to a table in which every fraction whose numerator is 2 and whose denominator is any odd number from 5 to 99 is resolved into the sum of fractions with unity as a common numerator. The following are examples:

$$\tfrac{2}{5} = \tfrac{1}{3} + \tfrac{1}{15},\ \tfrac{2}{7} = \tfrac{1}{4} + \tfrac{1}{28},\ \tfrac{2}{19} = \tfrac{1}{12} + \tfrac{1}{76} + \tfrac{1}{114}.$$

As this table is constructed according to no general rule, it is probable that it is a collection of results obtained by mathematicians during a long period of years. In fact some of these numbers are found in a mathematical papyrus which is many hundred years older than the work of Ahmes. This table, therefore, furnishes one of the many evidences of the fact that the early development of mathematics is largely based upon experiments. Comprehensive rules and theorems are a much later product.

From a modern point of view it might be said that the theory of arithmetical progression marked the highest point reached by Ahmes in arithmetic. He solves linear algebraic equations involving one unknown and considers the area of a circle equivalent to a square whose side is eight ninths of the diameter. This is equivalent to calling $\pi = 3.1605$, which is a much closer approximation than many later nations employed.* To find the area of an isosceles triangle he multiplied the base by half of one of the equal sides instead of by half the altitude. This inaccuracy seems to be due to the fact that the Egyptians did not know how to extract the square root of a number, and hence they could not find the exact area of such a triangle from its sides.

While the work of Ahmes is of the greatest interest to the mathematical historian, yet it contains few facts of sufficient generality or beauty to be classed among the fundamental discoveries in mathematics. It emphasizes rules rather than thought. In fact, it is practically confined to problems and answers, with the verifications of

* Read before the Science Association of Stanford University, November 5, 1902.

* Cf. I. Kings, ch. 7, v. 23 and II. Chronicles, ch. 4, v. 2.

some of the answers. It appears that the Egyptian did not make any additions to the work of Ahmes for more than a thousand years.

About the seventh century B.C. the Greeks showed such a deep interest in learning that they began to go to foreign countries (especially Egypt) in quest of knowledge. They soon excelled their teachers, and inaugurated a golden period of mathematical progress which has had no equal until recent times. Hence we naturally look to the Greeks for fundamental discoveries whose beauty and generality have engaged the admiration and interest of all who became acquainted with them.

One of the earliest of these is the proof that there are lines which do not have a common measure. Pythagoras observed that it is impossible to divide the side of a square into such a number of equal parts that one of these parts is contained an integral number of times in the diagonal. This fact made a very deep impression on the Greek mind. It is one of those great truths which can never be fully established by experiment, and yet does not rest on postulates or axioms which appear somewhat arbitrary. It thus stands in sharp contrast with the older discovery that the sum of the angles of a plane triangle is equal to two right angles, and deserves to be placed in a higher category of mathematical truths.

A scholium of Euclid's 'Elements,' which is supposed to be due to Proclus, bears evidence of the high regard which the Greeks had for the discovery of the incommensurable or the irrational. It reads as follows: "It is said that the man who first made the theory of the irrational public died in a shipwreck because the unspeakable and invisible should always be kept secret, and that he who by chance first touched and uncovered this symbol of life was removed to the origin of things where the eternal waves wash around him. Such is the reverence in which these men held the theory of the irrational quantities."

Aristotle frequently speaks of the fact that the diagonal of a square whose side is unity is irrational, and in one instance states that otherwise an even number would be equal to an odd number. The meaning of this is made clear by Euclid's proof of the fact that the $\sqrt{2}$, which is the value of the given diagonal, is irrational. Euclid says, in substance, if we assume that $\sqrt{2} = m/n$ a rational number, it follows that $2n^2 = m^2$. The fraction m/n may be supposed to be reduced to its lowest terms, and hence at least one of the two numbers m, n must be odd. This, however, makes the equation $2n^2 = m^2$ impossible, since the square of an even number is always divisible by 4 and the square of an odd number is odd. By dividing both members of the equation $2n^2 = m^2$ by 2 an odd number would be equal to an even number, as Aristotle says. It appears very probable that this elegant proof is due to the Pythagoreans, possibly to Pythagoras himself.

Another fundamental discovery of the Greeks is the use of infinite convergent series. Aristotle observed that the sum of an infinite number of small things may be finite and Archimedes frequently finds the sum of an infinite series in the solution of a problem. For instance, in finding the area of a portion of the parabola he observes that it is equal to the area of a given triangle multiplied by the infinite geometric series $1 + \frac{1}{4} + (\frac{1}{4})^2 + (\frac{1}{4})^3 + \cdots$ and he proves that the sum of this series cannot be greater or less than 4/3. His proof is practically the same as that found in our elementary algebras.

In finding the sum of such infinite series Archimedes answered in a very explicit and definite manner some of the difficult questions raised by Zeno two hundred years

earlier. For instance, Zeno argued that it was impossible to go from one place to another, because one would have to go one half the distance before arriving, but before going half the distance one would have to go one half of this half and so on to infinity. He also argued that Achilles could not overtake a tortoise which moved at one tenth his rate because by the time Achilles reached the place where the tortoise had been when he started the tortoise would have moved some distance ahead, and by the time Achilles reached this spot the tortoise would again have moved some distance ahead, and so on to infinity. These difficulties were completely solved by the Greek mathematicians, and further serious arguments along this line seemed to be based upon ignorance or perversity.

The Greeks were the greatest mathematicians of antiquity and Archimedes was the greatest mathematician among the Greeks. It is, therefore, of especial interest to learn what Archimedes himself regarded as his highest achievements. These consist of several important theorems in regard to the sphere, viz., that the volume of a sphere is two thirds of the volume of the circumscribed cylinder, and the area of the sphere is two thirds of the area of this cylinder. The beauty of these theorems impressed Archimedes so forcibly that he requested that a sphere inscribed in a cylinder should be marked on his tombstone. It is well known that Cicero discovered the grave of Archimedes by means of this inscription.

With the two theorems just mentioned Archimedes classed his closely related theorem, that the area of a zone with one base is equal to that of a circle whose radius is the distance from the base of the zone to its pole. These theorems may have appealed to Archimedes more forcibly on account of the fact that the Pythagoreans used to say that the sphere was the most beautiful of the solids and the circle the most beautiful of the plane figures. There are, however, few theorems in elementary mathematics which establish such unexpected and important facts.

The Greeks studied mathematics for its own sake. They cared little about the practical applications of their results. The following story about Euclid is characteristic: "A youth who had begun to read geometry with Euclid when he had learned the first proposition inquired, 'What do I get by learning those things?' So Euclid called his slave and said, 'Give him three oboli, since he must gain out of what he learns.'" The maxim of the Pythagoreans, 'A figure and step forwards, not a figure to gain three oboli,' is evidence of the same spirit.

In their disinterested search for truth they incidentally made more progress in practical results than was made by other nations who had these results directly in view. The fact that their extensive developments of the conic sections had to wait nearly two thousand years until they found application in the astronomical theories of Kepler, Newton and others is frequently cited as evidence of the importance of developing knowledge for its own sake.

Notwithstanding the remarkable achievements of the ancient Greeks we have to look to a less noted people for one of the most fundamental discoveries of elementary arithmetic, viz., the use of the zero. If we think how cumbersome arithmetic operations become when no use can be made of the zero, it may appear to us marvelous that Europe should have learned the use of this number symbol less than a thousand years ago.

At the last international congress of mathematicians the leading mathematical

historian, Moritz Cantor, expressed the opinion that the use of zero was probably due to the Babylonians 1700 B.C. However, it has not been definitely established that zero was in use any earlier than 400 A.D. About this time it was used in India, and several centuries later the Arabs began to employ it. Through the Arabs its use became known to Europeans during the twelfth century. It was not generally adopted in Europe until several centuries later, notwithstanding its great advantages. For a considerable time there were two parties among the European educators—one party, known as the algorists, favored the adoption of the Hindu system of notation (falsely called Arabic) with its position values, while the other, known as the abacists, favored the Roman notation without zero or position value.

The general adoption of the Hindu system was greatly facilitated by the facts that it was explained in most of the calendars for more than a century beginning with 1300, and that the medieval universities frequently offered courses devoted to the use of this notation. With the opening of the medieval universities we approach some of the fundamental discoveries in more modern mathematics. As we considered these on a similar occasion,* we shall merely add a few thoughts on the concept of dimensions which are due to Plücker.

The idea of more than three dimensions can be partially explained in a very simple manner. If the total number of points on a straight line is denoted by ∞ (the symbol for infinity), it is clear that there are ∞^2 points in a plane, since through each point of the given line we may draw a line at right angles to this line. Each of these ∞^2 points of the plane may be taken as the center of an infinite number of circles, and all the circles which have one point as center are distinct from those which have any other point as center. Hence there are ∞^3 circles in a plane, while there are only ∞^2 points in it.

We arrive at the same result by observing that an infinite number of lines may be drawn through each point of a plane and that each of these lines is tangent to an infinite number of circles going through this point. Hence ∞^1 circles pass through each point of a plane and lie entirely in the plane. As the number of points on a circle is infinite, the number of circles is obtained by multiplying the number of points by ∞. Hence we say that the plane is two-dimensional when the point is considered as the element, but it is three-dimensional if the circle is considered as element. If the ellipse were taken as element it could be readily shown that the plane would be five-dimensional.

Similarly space is three-dimensional if the point is taken as element but it is four-dimensional if the sphere is taken as element. Since there are ∞^6 pairs of points in space and ∞^2 pairs of points on a line there are ∞^4 lines in space, that is there is a 1, 1 correspondence between the lines and spheres of space. This is frequently expressed by saying there are just as many spheres in our space as there are lines, while the number of each of these is infinitely larger than the number of points. From this standpoint there is no limit to the number of dimensions of ordinary space.

G. A. MILLER.

* SCIENCE, Vol. XL. (1900), p. 528.

SCIENTIFIC BOOKS.

The Yuccæ. By WILLIAM TRELEASE. From the Thirteenth Annual Report of the Missouri Botanical Garden. Issued July 30, 1902. St. Louis, Mo. Published by the Board of Trustees. 1902. 8vo. Pp. 107.

The Spanish bayonets are shrubby or tree-like plants, principally of the genus *Yucca*, and represented in gardens by short-stemmed

species bearing evergreen, erect, sharp-pointed leaves. On the Great Plains a common species is known as the 'Dagger-weed.' In the southwest some of the species attain to the dimensions of trees, as *Yucca australis* and *Y. valida*, and are known as 'bear-grass,' 'palma loca,' 'izote,' etc. Botanically they are closely related to the lilies, and in fact are classed as members of the Lily family, of the tribe *Dracænoideæ*, and subtribe *Yucceæ*. All are natives of North America (including Mexico) and Central America.

In this paper the author describes thirty-four species and forty-five varieties and 'forms.' These are distributed quite unequally among five genera, as follows: *Hesperaloe*, two species, and one variety; *Hesperoyucca*, one species; *Clistoyucca*, one species; *Yucca*, twenty-eight species, and forty-five varieties and 'forms'; *Samuela*, two species. The species of *Hesperaloe* occur in Texas and Mexico, and have narrowed flowers, in contrast with the remaining genera, in which the flowers are broad. The single species of *Hesperoyucca* occurs in California, and may be recognized by its filiform style. In *Clistoyucca*, in which the style is wanting, we find a single branching arborescent species, which attains a height of twenty to twenty-five feet or more, and a stem diameter of nearly two feet. It occurs in the Mohave Desert of California, northwestern Arizona and southwestern Utah, where it is known as the 'Joshua tree.' The numerous species, varieties and 'forms' of *Yucca* are widely distributed, extending from South Dakota southward to central Mexico, and from the Atlantic Ocean to the Pacific. Species occur also in Central America, the Bermuda Islands and the eastern Antilles. The genus is distinguished by the polyphyllous flowers and short style. The plants range from acaulescent, as in *Yucca filamentosa* and *Y. flaccida*, to arborescent, as in *Y. australis* and *Y. valida*, which may attain a height of twenty-five to thirty feet. *Samuela* is a new genus erected by the author to include the species with tubular, gamophyllous flowers. Its two arborescent species are natives of Texas and northern Mexico.

One outcome of the studies on which this monograph is based is the conclusion that most of the Spanish bayonets grown in gardens under the old name of *Yucca filamentosa* are not of that species, but are varieties of the allied species, *Yucca flaccida*. The two species may be distinguished by the more rigid leaves, which bear coarse, curly threads in *Y. filamentosa*, and the more flexible leaves, bearing finer, straighter threads, in *Y. flaccida*.

The yuccas are of some value economically. All possess very fibrous leaves, and it is said that 'local use is made of the fiber almost everywhere that the plants grow.' The trunks of the larger species are locally used in the building of houses, palisades, etc., and the leaves are used for thatching. On account of their saponifying properties the stems and rootstocks of some species are used as a substitute for soap, and the species so used bear the local names 'amole,' 'soapweed,' 'soap plant,' etc. Apparently some use is made of this saponifying constituent in the manufacture of certain proprietary soaps and detergent compounds. The flowers and young leaves of many species are greedily eaten by cattle. In the Nebraska sandhills the present writer has seen many examples of plants which had been broken down and their young leaves eaten by the hungry cattle, and in these regions it is very difficult to find complete flower panicles, on account of the greediness of the cattle in eating the succulent flowers. In Mexico the flower clusters of *Samuela carnerosana* are gathered for feeding to sheep and other domestic animals, and it is the practice of the inhabitants to split open the thick trunks of this species in order that the succulent interior portions may be eaten by stock. The fruits of the baccate species are eaten by the natives, as are the young flower buds of some species when roasted or boiled. The seeds are ground and used as meal or boiled into a mush for human food, in some localities. Lastly, attention may be called to the ornamental value of many species, and for this purpose they are largely employed, especially in gardens and parks of considerable extent. They are not adapted to small

grounds, where their sharp-pointed leaves are quite annoying.

It is not necessary to refer at length to the well-known dependence of the yuccas upon certain insects for the deposition of the pollen on the stigmas of the flowers, since that has been so frequently described by many observers. Such dependence seems to be general throughout the group. Even in *Samuela*, with its oddly narrowed, tubular perianth, the common yucca-moth (*Pronuba yuccasella*) is shown to be the agent in pollination.

The monograph is richly illustrated by eighty-eight plates of plants and their fruits and seeds, besides twenty-four maps showing the distribution of the species. American botany is to be congratulated on the publication of this admirable monograph.

CHARLES E. BESSEY.

UNIVERSITY OF NEBRASKA.

A List of North American Lepidoptera, and Key to the Literature of this Order of Insects. By HARRISON G. DYAR. Bulletin 52, U. S. National Museum. 1902 [February, 1903]. Pp. 723.

For many years the guide and companion of the European lepidopterist has been Staudinger's 'Catalogue of the Lepidoptera of the Palæarctic Faunal-region.' The veteran author of that work has now died, leaving us a new edition, prepared in conjunction with Dr. H. Rebel. In America we have had nothing equivalent to Staudinger's catalogue, although Dr. J. B. Smith's useful check-list of 1891 served to indicate the names and classification of the species. At last, however, Dr. Dyar has given us a detailed catalogue, including full references to literature and brief indications of localities. In preparing this work, Dr. Dyar has been assisted by Dr. C. H. Fernald, Rev. Geo. D. Hulst and Mr. August Busck, as is carefully acknowledged on the title-page; he has also utilized previous lists, so far as they proved serviceable. The literature of the subject has been searched with extraordinary care, and full advantage has been taken of the most recent advances in our knowledge of the classification of the Lepidoptera, many of them due to Dr. Dyar himself. While there are of course a few errors in copying or printing, these are extremely few, and the work as a whole is exceedingly well done. If any of us are inclined to regret that a man like Dr. Dyar, one of the most original and gifted investigators in America, should spend his time in preparing a catalogue, we may console ourselves by recollecting the character of some other catalogues, prepared by men of less ability. In truth, the thing was well worth while, and its value to students of American lepidoptera can hardly be overestimated.

The Staudinger and Rebel catalogue for the Palæarctic Region, published in 1901, includes the names of nearly 4,800 species. Dyar's list (including 44 interpolated since it was made up) includes 6,666 species, occurring in America north of the Mexican boundary and the West Indies. This is not precisely equivalent to the Nearctic region, as it excludes the tableland of Mexico, and includes certain Neotropical elements represented in southern Florida. In all probability, our region is much richer in species than the Palæarctic, as it is quite certain that our lists are very incomplete in respect to the smaller moths. In parts of the southwest, indeed, it appears that new species of microlepidoptera are so abundant that the most superficial collector can not fail to find some, while the harvest to be reaped by systematic collecting and breeding is almost unlimited.

It is difficult to determine exactly the degree of resemblance between the lepidopterous faunæ of the Palæarctic and Nearctic regions, but while the two have even a number of species in common, they are in most respects very different. Taking the index of the Palæarctic (Staudinger and Rebel) catalogue, I find 326 valid genera enumerated under the first three letters of the alphabet. Of these, only 97, or less than 30 per cent., are found in Nearctic region. The difference would seem even greater if one took the names just as they stand in the two catalogues, because different views about nomenclature have given us in many cases different names for the same genus. It is very likely that a more exact comparison between the Palæarctic and Ne-

arctic genera will lead us to unite many supposed to be distinct, but the fact will remain that the two faunæ are very dissimilar. Every lepidopterist who has collected on both sides of the Atlantic can remember conspicuous European genera wanting in America, and *vice versa*. In a work of such magnitude as the one under review there are of course some things that may be criticised adversely. A few of these may be regarded as simple errors, but most are objectionable to the reviewer only because his opinions differ from those of the author. The greatest fault, as it seems to me, is the illogical treatment of varietal names, but it must be confessed that their proper treatment is a matter of great difficulty. If it were proposed to discard all names applied to mutations or seasonal forms, and let the trinomial always stand for a geographical race or subspecies, this would at least be logical. In the list, however, we find pure synonyms, names of aberrations and some names of geographical races, lumped together as synonyms of the species, so that it looks to the uninitiated as if modern writers had proposed new specific names for the commonest and best-known butterflies! On the other hand, as valid varieties appear subspecies, seasonal forms and in some cases mere individual variations. Under *Eurymus*, the albinic females of two species appear as valid varieties, while precisely similar forms of others are placed in the synonymy or wholly ignored. The fact is, our American lepidopterists have been so busy describing the new species continually coming to hand, that they have not had time to consider a philosophical plan for recording the different kinds of variation. This work, hitherto somewhat despised, is for the future, and when it is properly done we shall see its great value from the standpoint of evolution.

The treatment of localities in the list is unsatisfactory, being in many instances incomplete, some few species being only recorded as coming from a foreign country, though we presume from their presence in the catalogue that they have been taken in the United States. A really adequate account of the distribution of the American lepidoptera could not be prepared at the present time, as its necessary basis, a good series of local lists, does not exist.

Several species are very briefly described as new in the list. The descriptions are hardly adequate, and no precise localities are given, but I understand from Dr. Dyar that a future paper will remedy these deficiencies. Several generic names are changed because of homonymy; some of the changes have been made because of prior similar but not identical names, such changes being, in my opinion, unnecessary and undesirable. It has been overlooked that *Trama* is the name of a genus of Aphididæ. The later lepidopterous *Trama* (Harvey), *Bull. Buff. Soc.*, 1875, may be called *Lepidotrama*, a name I had given it in MS. some years ago. The species are *Lepidotrama detrahens* (Walker), *L. hinna* (Geyer) and *L. griseipennis* (Grote). The butterfly genus *Tachyris*, described by Wallace, is curiously credited to Wallengren. The generic nomenclature of the butterflies follows in the main the conclusions reached by Scudder many years ago, and is consequently materially different from that in current use. The actual omissions are very few; one notices at the very beginning the absence of *Parnassius nomion minor* Elwes, and *Iphidicles ajax floridensis* (Holland). For no. 475, I would write *Copœodes waco* (Edw.), and *C. waco procris* (Edw.), the name *waco* being the older. The printing of the work is admirable, but the binding is very poor.

T. D. A. Cockerell.

East Las Vegas, New Mexico,
February 28, 1903.

Disinfection and Disinfectants. By Dr. M. J. Rosenau.

This book containing 350 pages is divided into three sections. The first part deals with the best of the disinfectants and insecticides in common use. The second deals with the places and objects to be disinfected. In the third part the important communicable diseases are considered separately, and the characteristics of the bacteria peculiar to them and the special means required to destroy them described. Malaria and yellow fever are given special mention.

The book is a safe and valuable guide and should prove very useful to health officers, physicians and all intelligent persons who desire to understand the principles of disinfection. There is only one important statement that I take exception to, and here the error is on the side of safety. It is stated that disinfection with the fumes of burning sulphur requires eighteen to twenty-four hours, and that the injurious effect on fabrics of this disinfectant contracts its use to narrow limits.

In places where each family occupies an entire house it may be possible to require people to vacate rooms for eighteen hours, but in tenements such as occur in cities this is impossible. We have found, however, that when a room is tightly sealed and four pounds of sulphur are burned to each 1,000 cubic feet, disinfection is practically complete in eight hours, when penetration is not required and the microorganisms to be killed are not more resistant than those met with in diphtheria and small-pox. Its cheapness, ease of use and its value as an insecticide cause us to use sulphur rather than formaldehyde in the rooms requiring disinfection in the tenements of New York city.

WM. H. PARK.

Mineralogy. By H. A. MIERS. The Macmillan Co., 8vo. Pp. 584.

Mr. Miers, for a long time connected with the mineralogical department of the British Museum and now professor of mineralogy in the University of Oxford, has had unusual facilities for the study of mineral specimens, and his book is the result of many years of labor. As stated by the author in his preface, the volume is not an exhaustive system of mineralogy, but is intended rather as a treatise in which students will find all that is required for an elementary acquaintance with the subject. The difficult subjects of mathematical crystallography and the physical properties of crystals are treated carefully and with much detail, and the chapter on the optical properties of crystals is especially helpful and suggestive. In the part treating of descriptive mineralogy, comprising about one half of the volume, essentially the same classification as adopted by Dana is followed. In the description of species the crystallographic characteristics are given with much detail, and the text is illustrated not only by the usual outline figures of crystals, but also by numerous carefully executed and effective shaded drawings, many of them of characteristic specimens in the British Museum. At the close of the volume there are given tables of minerals arranged according to the chemical classification, optical properties and specific gravity.

The book is one which advanced students will find useful in the study and comparison of specimens, but it is scarcely elementary enough to serve as a text-book for beginners. The volume is handsomely gotten up, and in this respect may serve as a model for books of its kind.

S. L. PENFIELD.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for February opens with an important paper on 'The Structure and Relationships of the American Pelycosauria,' by E. C. Case. The author concludes that all known reptiles from the American Permian possessed two temporal arches and that the Pelycosauria followed a line of development here that led to extinction, the persistent line of development being followed elsewhere. These points are dwelt on in a description of the cranial features of various species. V. Sterki presents some 'Notes on the Unionidæ and their Classification,' and gives a scheme of classification, differing somewhat from that of Simpson, based largely on the structure of the hinge, shape of the embryonic and adult shells, and condition of the marsupia. E. L. Mark describes 'A Paraffine Bath Heated by Electricity,' intended to do away with the danger of explosion that attends the use of gas. The number contains the Quarterly Record of Gifts, Appointments, Retirements and Deaths.

THE February number of the *Botanical Gazette* contains the first half of a paper by Dr. E. B. Copeland on 'Chemical Stimula-

tion and the Evolution of Carbon Dioxid.' In this part he summarizes previous contributions to the subject and describes improved apparatus for respiration experiments, and an accurate method of titration, on which the somewhat surprising results to be set forth in the second instalment are based.—Professor Charles S. Sargent enumerates the species of 'The Genus *Cratægus* in Newcastle County, Delaware,' including notes on the old species, and the description of eight new species and two new varieties.—Mr. William H. Long, Jr., monographs 'The Ravenelias of the United States and Mexico.' From the genus *Ravenelia,* the species *R. Holwayi,* having æcidia without pseudoperidium, is separated to constitute the genus *Neoravenelia,* and the six species having the inner teleutospores two-celled are segregated as a new genus, *Pleoravenelia.* Three new species of *Ravenelia* and two of *Pleoravenelia* are described. Diagnostic structures of the various species are shown on the two double plates.—Frederick H. Billings has found chalazogamy in the pecan, whose close alliance with the walnut, in which this mode of tube entry was first described, makes the discovery seem quite natural. Mr. W. C. Coker contributes various brief notes; one on leaf variation in *Liriodendron;* another on the occurrence of two egg cells in the archegonium of *Mnium,* from each of which a ventral canal cell is cut off; another on the nucleus of the spore cavity in prothallia of *Marsilia.* This nucleus enlarges greatly as development of the prothallium proceeds, protrudes two or more arms and filaments toward the prothallium, and later fragments amitotically.—Mr. Westgate reviews Gerhart's book on dune work in Germany, and Mr. Howe the volume of Boppe and Joylet on the forests of France.—There are nine pages of notes on current literature and three pages of news items.

The Popular Science Monthly for March contains some 'Hitherto Unpublished Letters of Charles Darwin,' an account of 'The Vienna Academy of Science,' by Edward F. Williams, and the eighth paper by Frederick A. Woods on 'Mental and Moral Heredity in Royalty,' which considers the evidence from Lehr's Genealogy. Edwin G. Dexter considers 'High-Grade Men: In College and Out,' presenting some evidence to show that men who stand high in college retain their position in after life. Raphael G. Zon discusses 'The Source of Nitrogen in Forest Soil' and R. H. Thurston 'Education for Professions,' summing up that prerequisites for success are perfect training of body, brain and soul. John Quincy Adams considers 'Science *versus* Art-Appreciation,' but we believe he errs in stating that science has not only driven art into the background, but has misrepresented its character. The concluding article is by S. W. Williston, on 'The Fossil Man of Lansing, Kansas,' giving a good description of the conditions under which the remains were found and a careful consideration of the possible age of the specimen. 'The Progress of Science' contains critical articles on the Smithsonian Institution and Carnegie Institution.

The Plant World for February contains the third instalment of 'Extracts from the Note-Book of a Naturalist on the Island of Guam,' by W. E. Safford, 'Notes on the Flora of Central Chile,' by George T. Hastings, 'Conditions of Plant Growth on the Isle of Pines,' by W. W. Rowlee and other shorter articles.

The Museums Journal of Great Britain for February has 'A Design for the Tops of Table Cases,' by A. Jukes-Brown, and a consideration of 'The Use of Museums in Teaching,' by W. E. Hoyle, with special reference to the Manchester Museum. Among the notes is one entitled 'A Statesman's View of Museums,' showing the high value set on them by Mr. James Bryce, and the announcement of the completion of a large additional building for the Kew Herbarium.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY.

A REGULAR meeting of the Section of Geology and Mineralogy was held on the evening of February 16, at the American Museum of Natural History, with Professor J. F. Kemp in the chair.

Professor William Hallock read the first

paper, on 'An Ascent of Mt. Whitney, California, with Notes on the Geology.' Mt. Whitney, with an altitude of 14,625 feet, claims the distinction of being the highest peak in the United States. It is a mountain of high relief in a rugged country. The easiest way to the summit is by a five-day journey skirting the canyons from the southwest. Sedimentary rocks are not met with in this part of the Sierras, near Mt. Whitney. The country rock is a deeply weathered granite, split up by countless joint planes. Mt. Whitney exhibits the effects of glacial sculpturing, and holds many small lakes in the cirques, adjacent to its top, which have resulted from ice undercutting. Professor Hallock also described a lava flow with cinder cones on Volcano Creek, Cal. Lantern slides were used to bring out these features, and to illustrate the topography.

Professor Kemp read the second paper, on 'The Leucite Hills of Wyoming.' Before giving an account of his work in this region with Professor Wright, of Wyoming University, he described the mineralogical and petrographical features of the leucite rocks as they occur in America, and referred to their discovery in Wyoming by the members of the 40th Parallel Survey. These rocks were originally described by Dr. Zirkel. The speaker then called attention to Dr. Cross's more extended work in the district. His own contribution had to do with the general geology of the Leucite Hills. As many as seventeen separate mesas and buttes isolated by erosion have been mapped, representing in most cases single extrusive and intrusive flows of these rare rocks. They are found in sandstones near the top of the Cretaceous, and their distribution and field relations tend to confirm the view that they are volcanic outpourings at different times from a laccolithic reservoir of great extent, which is nowhere exposed at the surface. Lantern slides were used in illustrating the geology, and specimens of the rocks in question were exhibited.

GEORGE I. FINLAY,
Secretary pro tem.

COLUMBIA UNIVERSITY GEOLOGICAL JOURNAL CLUB.

February 13.—The concluding discussion of the new classification of the igneous rocks was opened by Professor Kemp. It was actively participated in by members of the club. The educational aspect of the subject was particularly considered.

Dr. Julien reviewed two short papers from a late number of the *Bulletin de la Société Geologique de France.*

February 20.—Mr. D. W. Johnson reviewed a paper by W. M. Davis on the 'Fresh-water Tertiary Formations of the Rocky Mountain Region,' and then gave a paper on the 'Fluviatile Origin of the Santa Fe Marls in New Mexico.' This paper aroused much discussion. Dr. A. F. Rogers exhibited some specimens of galena showing multiple twinning.

February 27.—Dr. Julien reviewed several papers in a late number of the *Bulletin de la Société Geologique de France,* especially an essay by H. Douvillé on the 'Revision and Distribution of Orbitolites and Orbitoides from the Chalk.' Professor Grabau reviewed a late paper by Mr. Schuchert on the 'Lower Devonic and Ontaric Formations of Maryland.'

H. W. SHIMER.

THE CONNECTICUT BOTANICAL SOCIETY.

THE society was organized in New Haven, January 24, 1903, and the following officers elected:

President—Professor Alexander W. Evans.
Vice-President—Dr. C. B. Graves.
Recording Secretary and Treasurer—Dr. E. H. Eames.
Corresponding Secretary—Mr. E. B. Harger, Oxford, Conn.

For the compilation of accurate information towards a catalogue of the flora of the state, a committee on the higher plants was appointed, while another on the lower cryptogams remains to be selected.

The former committee consists of Dr. C. B. Graves, New London; Dr. E. H. Eames, Bridgeport; Mr. C. H. Bissell, Southington; Mr. L. Andrews, Southington; Mr. E. B.

Harger, Oxford, and Mr. J. N. Bishop, Plainville.

Several papers were heard with great interest, followed by much discussion on these and botanical matters in general. It was also decided to hold field meetings at intervals through each season, more thoroughly to study the flora of the state, and give additional stimulus to the prosecution of careful work in this direction.

Withal, the meeting was very enjoyable, and indicated a permanently active organization.

Thirty-one members were accepted as organizers of the society and the probability of greatly increased membership is already apparent.

E. H. Eames,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 368th meeting was held Saturday, March 7.

F. A. Lucas exhibited some lantern slides made from photographs taken by R. H. Beck, showing groups of several hundred specimens of *Conolophus cristatus,* one of the two large lizards found on the Galapagos Islands. Mr. Lucas stated that Mr. Beck had taken a large number of photographs showing the more striking features of the fauna and flora of those islands.

Frederick W. True spoke on the 'Attitudes and Movements of Living Whales,' illustrating his remarks by lantern slides showing whales as depicted in books and as they actually appear in life. The species discussed were the large whales pursued for commercial purposes, and the speaker showed that there was considerable discrepancy in the accounts of observers as to their behavior. Under this was included the form and height of the spout, the movements of tail and flippers, duration of stay beneath the surface and method of descending, or 'sounding.' Various observations were plotted on a large diagram, and attention was called to the fact that the closest agreement as to facts was found in observations made on the bowhead and sperm whales, the two species that had been longest hunted and were best known. It was suggested that with better knowledge of other species there would be better correspondence of the observations concerning them.

O. F. Cook presented 'Some Biological Aspects of Liberia,' exhibiting a number of views of the more characteristic features of the flora and describing in detail some of the more interesting trees and plants. It was stated that the oil palm was the only African palm not represented by some species in South America, and attention was called to the fact that this palm was not found in a wild state. Where it seemed to occur wild, observation showed that the spot had formerly been inhabited and the species was preserved and disseminated by the agency of man.

F. A. Lucas.

DISCUSSION AND CORRESPONDENCE.

THE PUBLICATION OF REJECTED NAMES.

In the issue of Science for January 30, 1903, p. 189, Professor T. D. A. Cockerell, under the above caption, calls attention to what he regards as adequate publication of rejected manuscript names by Mr. Banks and myself. As Professor Cockerell very well says, there is evidently a misconception or divergence of opinion among naturalists on this point that it is well worth while to discuss. I have taken the trouble to submit my particular case to some forty workers in systematic biology, and the 'various and sundry' ways that have been suggested for handling the question are certainly surprising, showing that the practice in such cases is by no means uniform. A large number, mainly zoologists, hold that my printing of Lesquereux's manuscript name *Carya globulosa* before the one I intended to give the organism was merely of the nature of narrative or explanation, and did not have the effect of validating the manuscript name. The intent of the author, it is said, is to be respected, and as it is perfectly clear that I intended to name it *Cucumites Lesquereuxii* and not *globulosa,* they hold that *Cucumites Lesquereuxii* stands. Others take an exactly opposite view, namely, that because I printed the manuscript name first and followed it by a description of the

fossil before printing the name I proposed to give it, I thereby validated the manuscript name, and no matter how plain the author's intent may have been, the specific name *globulosa* must prevail. They would, therefore, write the binomial as *Cucumites globulosus*. Accepting this latter view, an immediate and pronounced divergence of opinions arose as to the authority for the specific name and its combination. Some aver that, although I did mention Lesquereux's manuscript name, I was the first to rescue it from the limbo of *nomina nuda* and habilitate it by means of a description and illustration, hence it became my name. Those who hold this view would write it *Cucumites globulosus* (Knowlton), or if using the double citation, as *C. globulosus* (Knowlton) Cockerell, on the ground that Cockerell first actually made the combination in his note in SCIENCE. Others, all of them botanists, claim that *globulosa(us)* was Lesquereux's specific name which I had obligingly published for him, and that the authority should read: *Cucumites globulosus* (Lesquereux) Cockerell. Still others argue that although I did not actually refer *globulosa* to the genus *Cucumites* I virtually did so, and they would write it *C. globulosus* (Lesquereux) Knowlton. This last contingent, while denying the right to interpret my obvious intention to give the plant a new name, insist on supplying me with an intention to do that which I did *not* intend!

Tabulated we have the following results:

Cucumites Lesquereuxii Knowlton. Advocated by twenty-one systematists, mainly zoologists.

Cucumites globulosus (Knowlton). Advocated by two zoologists.

Cucumites globulosus (Knowlton) Cockerell. Advocated by six zoologists.

Cucumites globulosus (Lesquereux) Cockerell. Advocated by eleven botanists.

Cucumites globulosus (Lesquereux) Knowlton. Advocated by two botanists.

It may be worth while to attempt an analysis of the above diverse results to see if it is possible to ascertain the underlying principles which governed the several decisions. Those who advocate the first combination in the above list would seem to be going on the common-sense principle, namely, that the obvious intention of the author should be respected. This, as I understand it, the so-called Kew Rule permits. But it is very much with this as it is when a game is played with cards. It might be most logical for each card to have a fixed value, but when different games are played they are played according to the rules of the particular game, and the cards have the value fixed by the rules of that game. The ornithologists are supposed to be playing, to continue the simile, according to the rules of the American Ornithologists' Union, which, on the point at issue, is as follows:

"§ 5. Of names published simultaneously. Canon XVII., 3. Of names of undoubtedly equal pertinency, * * * that is to be preferred which stands first in the book."

As it is beyond question that the name *Carya globulosa* appears first in my paper, and is followed by a full description of the organism, the above rule would seem to fix *globulosa* as the proper specific name. In the matter of deciding the authority, Canon XXXII. of the A. O. U. code is very plain. This reads: 'A *nomen nudum*, generic or specific, may be adopted by a subsequent author, but the name takes both its date and authority from the time when, and from the author by whom, the name becomes clothed with significance by being properly defined and published.' In conjunction these rules fix the name as *Cucumites globulosus* (Knowlton).

The botanists are supposed to be working under the so-called Rochester rules, and this point is covered in part by Article VI., Publication of Species. 'Publication of a species consists only (1) in the distribution of a printed description of the species named.' As these conditions are fulfilled in my paper, this rule also fixes the specific name as *globulosa*. There appears to be no provision in the Rochester rules for fixing the authority in cases like this one under discussion.

In conclusion I may say that I am forced to agree with Professor Cockerell that *under the rules* the name of the Vermont fossil must

be *Cucumites globulosus,* although I am free to confess that is not the name I had intended it to bear! I would write the name and its authority as *C. globulosus* (Knowlton) Cockerell, and I may add, that, in my judgment, Professor Cockerell has himself further complicated the issue by intentionally publishing a combination in a field in which he has at most only a passing interest.

F. H. Knowlton.

Washington, D. C.

THOSE MANUSCRIPT NAMES.

To the Editor of Science: I am much averse to using the pages of scientific papers for nomenclatorial discussion, but since Professor Cockerell's and Dr. Bather's articles indicate that I introduced MS. names merely to upset them, a few words may not be amiss. Dr. Bather says 'It (*Filistata oceanea*) appears first on page 50 of Mr. Banks's paper.' Such is not the case, and in this very paper (p. 60, bottom) I refer to an unpublished name of Marx but am careful not to introduce it. Dr. Marx (as I state) published a list of spiders from the Galapagos Islands in 1889 which includes six MS. names. In order to make my paper on the spiders of these islands complete it was necessary to note previous publications. In order to show how many spiders were known from these islands I collated the previous lists (Butler's and Marx's) with my material, in so showing that three of Marx's published names were synonyms of previously described species, and two others were the same as those I would describe below. In sinking five of the six previously published names (every one of which is still a *nomen nudum*) under described species I believe I was doing a service. My case is not unique; I can mention dozens; commonly, however, the MS. name is referred to after the description. And the paper and ink wasted in so doing are as nothing to the time and type wasted in the two articles which are the mismated parents of this one. Nathan Banks.

EXPLORATION OF OKEFINOKEE SWAMP.

To the Editor of Science: Some of your readers may be interested to know that the vast wilderness, several hundred square miles in extent, known as Okefinokee Swamp, in southeastern Georgia, so long avoided by botanists and other scientists—though mentioned as long ago as 1791 in the writings of William Bartram—has at last been penetrated. In company with Mr. P. L. Ricker, of the U. S. Dept. of Agriculture, and a guide, I entered the swamp near the center of its eastern margin on August 6, and came out at the same place on the 8th, having in the meanwhile been about a dozen miles into the interior and secured a considerable number of interesting plants and photographs.

One of the first features of the swamp to attract my attention was the fact that all the thousands of cypress trees seen were undoubtedly *Taxodium imbricarium,* a species whose distinctness from the old *T. distichum* I have recently attempted to show (*Bull. Torr. Bot. Club,* 29: 383–399, June 20, 1902). According to the theory there proposed (see pp. 389, 395) this would seem to indicate that the Lafayette formation underlies the swamp, or at least that part of it visited by us; but direct evidence on this point is still wanting. This formation was actually observed however a few miles east of the swamp, and it is reasonable to suppose that it underlies the whole area.

Lumbering operations in the swamp seem to have been suspended for the last few years (owing mostly, it is said, to the death of the principal promoters of the scheme for deforesting and draining it), and fortunately the natural conditions have been very little altered thereby. The fauna seems to have suffered considerably from the ravages of sportsmen, but the flora is practically intact, and the swamp offers a number of most interesting problems in many branches of natural science.

Roland M. Harper.

Folkston, Charlton County, Georgia,
August 11, 1902.

SOUTHERLY DEVIATION OF FALLING BODIES.

Readers desiring a somewhat fuller historical account of experiments and theories relating to the southerly deviation of falling

bodies than that given by Professor A. Hall in this journal, p. 349, are referred to my article in SCIENCE, N. S., Vol. XIV., pp. 853–855. The experiments by Professor E. H. Hall, recently outlined in this journal, p. 181, are extremely interesting. They seem to indicate a minute southerly deviation. Thus nearly all experimentalists on this subject, from the time of Robert Hooke to the present, have found a small southerly deviation. I believe the only exception is Benzenberg, who in 1804 had, for theoretical reasons, come to disbelieve in the actual existence of this deviation, and who, accordingly, found it absent in his experiments of that year after selecting from the total number of trials those only which, in his judgment, were made under the most favorable conditions. I read Benzenberg's and other papers in *Gilbert's Annalen* two years ago and I can not recall that Benzenberg, or any one else, ever announced a *northerly* deviation. In 1802 Benzenberg reported, as a final result of his experiments in Hamburg, a marked southerly deviation. In the following summary, H = height in m., $S.D.$ = southerly deviation in mm., A = average southerly deviation in mm., per meter of fall.

	H.	S. D.	A.
Hooke, 1680,	8.3	+	
Guglielmini, 1791,	78.3	11.89	.15
Benzenberg, 1802,	76.3	3.4	.044
Benzenberg, 1804,	84.4	0.00	.00
Reich, 1831,	158.5	4.374	.028
Rundell, 1848,	400.	250 to 510	.95
E. H. Hall, 1902,	23.	.05	.002

FLORIAN CAJORI.

COLORADO COLLEGE,
March 3, 1903.

SHORTER ARTICLES.

PYCRAFT'S CLASSIFICATION OF THE FALCONIFORMES.*

PROBABLY no recent paper on the classification of any group of birds is equal in interest or importance to that by Mr. W. P. Pycraft on the osteology and classification of the Falconiformes, a group in which the crudities of earlier systems have been held on to with a persistence most remarkable in these days of advanced knowledge of avian anatomy. Until the appearance of Huxley's celebrated paper, in 1867* all naked-headed carrion-feeding birds of prey were 'Vulturidæ' (vultures), the superficial resemblance between those of the Old World and those of the New being, in those days of anatomical ignorance, far more obvious than the external differences, marked though they be. Although in separating the American vultures as a distinct family, Cathartidæ, Huxley drove the first nail in the burial case of the old systems, he unfortunately went no farther concerning the typical Falconiformes,† and, therefore, ornithologists have continued to recognize the purely artificial and unnatural minor groups of the older authors. All those of largest size, except vultures, are still 'Aquilinæ' (eagles), in the latest arrangements; all those with exceptionally long wings and more or less forked tails‡ are 'Milvinæ' (kites); all short-winged, long-legged and long-tailed forms 'Accipitrinæ' (hawks); those of heavy build, moderate size and alleged 'sluggish' habits 'Buteoninæ' (buzzards); while those with notched bills are 'Falconinæ' (falcons).

Although, as before remarked, Huxley's paper went scarcely beyond the definition of the three primary divisions of the order, he fortunately gave a valuable clue to further

* Pycraft, W. P., F.Z.S., A.L.S., 'Contributions to the Osteology of Birds,' Part V., *Falconiformes*. *Proc. Zool. Soc. Lond.*, 1902, Vol. I., Part ii., August 1, 1902, pp. 277–320, pls. xxxiii.–xxxvii.

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* 'On the Classification of Birds; and on the Taxonomic Value of the Modification of certain of the Cranial Bones observable in that Class,' by Thomas H. Huxley, F.R.S., V.P.Z.S. *Proc. Zool. Soc. Lond.*, 1867, pp. 415–472. (The Ætomorphæ, = Falconiformes + Striges, treated on pp. 462–465.)

† He divided the so-called diurnal raptores into three groups, Cathartidæ, Gypaëtidæ, and Gypogeranidæ, each equivalent to the suborders Cathartæ, Accipitres, and Serpentarii of Pycraft.

‡ All these artificial groups, however, contain forms which do not conform to the diagnoses of said groups, some so-called 'kites,' for example, having a truncated or even rounded tail, and some 'eagles' being no larger than the average hawk.

investigation within the group which he called Gypaëtidæ (*i. e.*, the Accipitres) in certain variations of the coracoid and scapula. Taking up this clue, the present writer published, in 1873–1876, a series of papers on the classification of the Accipitres, and in the first of these* indicated a new grouping of the genera, but without definition of their characters, the salient feature of the new arrangement being the separation of the true falcons (Falcones), laughing falcons (Herpetothereæ), wood falcons (Micrastureæ) and caracaras (Polybori) as a subfamily (Falconinæ), the remaining members of the order being segregated into minor groups under the subfamily heading Buteoninæ. This arrangement was further elaborated, with slight modifications as to some of the minor groups, in 1875 † and again in 1876.‡

This 'new arrangement,' so radically different from any other, found little favor among ornithologists, and had apparently become forgotten; therefore, the author hopes that he may be excused the surprise and gratification which he naturally feels to find in Mr. Pycraft's paper, published nearly thirty years later, a classification so closely identical with his own that differences of nomenclature constitute almost the only points of divergence. No mention of the present writer's papers of 1873–76 on the same subject being made by Mr. Pycraft, it is probable they were unknown to him, or at least that he never saw them, a probability the more gratifying since results which have been independently reached by two widely separated investigators must, necessarily, be sound; and now that the 'stamp of authority' has been given to the present writer's long ignored arrangement, it will be safe for the conservative ones to shake off their adherence to antiquated and obviously unsound classifications of the group and adopt the modern one. The latter, it is hardly necessary to remark, is of course susceptible of much improvement, especially as to the number and limits of the minor groups (called subfamilies by Mr. Pycraft), there being still many forms whose osteology has not yet been studied.

In order to show how very closely the present writer's arrangement of 1873–76 coincides with Mr. Pycraft's of 1902, the two are compared in parallel columns, with a few necessary explanatory notes:

Ridgway (1873–76).	Pycraft (1902).
Falconinæ (1873).	Falconidæ.
Falcones (1873).	Falconinæ, part.
Polybori (1873).	Polyborinæ.
Micrastureæ* (1873).	Falconinæ, part.
Herpetothereæ† (1873).	Falconinæ, part.
Buteoninæ (1873).	Buteonidæ.
Pandiones‡ (1873).	Pandioninæ?
Pernes§ (1873).	Perninæ, part.
Elani‖ 1873).	Elaninæ.
Ictiniæ¶ (1873).	Milvinæ, part?
Elani* (1873).	Circinæ,** part.

* Changed in 1875 to Micrastures.

† Changed 1875 to Herpetotheres.

‡ My Pandiones originally included *Elanoides*, which in 1875 I transferred to Pernes, where it is placed by Mr. Pycraft.

§ My Pernes included the genera *Pernis, Baza, Avicida* '*Cymindis*' (*Odontriorchis*), and *Regerhinus*. To these Pycraft adds, doubtfully, *Pandion*, not being satisfied as to the propriety of separating it as a subfamily. *Elanoides* was added to the group by me in 1875.

‖ My Elani originally included only *Elanus* and *Gampsonyx*, but *Nauclerus* was added in 1876. Mr. Pycraft does not mention the last, but includes *Machærhamphus*, a genus which I had not been able to examine.

¶ This group includes *Ictinia* and *Harpagus*, the former being doubtfully referred by Pycraft to the Milvinæ (where most certainly it does not belong), while the latter is not mentioned by him. *Rostrhamus* is also doubtfully referred by Pycraft to the Milvinæ, a group to which it seems to me to be not at all nearly related.

** Pycraft includes, besides *Circus* and '*Strigiceps*,' the genera *Urotriorchis* and *Geranospizias*,

* 'Catalogue of the Ornithological Collection in the Museum of the Boston Society of Natural History,' II., Falconidæ. *Proc. Boston Soc. Nat. Hist.*, XVI., May 21, 1873, pp. 43–106.

† 'Outlines of a Natural Arrangement of the Falconidæ,' *Bull. U. S. Geol. and Geog. Surv. Terr.*, No. 4, second ser., June 10, 1875, pp. 225–231, pls. xi.–xviii.

‡ 'Studies of the American Falconidæ,' *Bull. U. S. Geol. and Geog. Surv. Terr.*, ii., No. 2, April 1, 1876, pp. 91–182.

Geranospizæ (1873).*	Circinæ, part? (or Circætinæ, part?).
Urubitingæ (1873).	Urubitinginæ,† + Buteoninæ, part.
Buteones (1873).	Buteoninæ,‡ part.
Haliaeti§ (1873).	Milvinæ.
Aquilæ‖ (1873).	Aquilinæ.
Circaëti¶ (1873).	Circaëtinæ.
Archibuteones** (1873).	Buteoninæ, part.
Morphni (1876).	Thrasaëtinæ.

The only group of Mr. Pycraft's classification having no equivalent in my arrangement is his subfamily Vulturinæ (comprising the genera *Gypohierax, Neophron, Gyps, Vultur* and *Otogyps*††). This subfamily he locates between the Thrasaëtinæ and Circaëtinæ, a position not far different from that I would have given it had occasion required, as is indicated on page 227 of my 'Outlines.'

That Mr. Pycraft was unable to give the preparation of his paper the amount of time and care which the subject would have justified is obvious from several slips, nomenclatural and otherwise. For example, he places the Polybori (his Polyborinæ) both in the Falconidæ and Buteonidæ (p. 315), and *Geranospizias* in both Circaëtinæ and Circinæ! In different places the terms Accipitridæ and Buteonidæ are used for the same family. There are also some errors in the explanations to the plates, fig. 10, pl. 32, representing *Catharistes,* not *Serpentarius,* Fig. 11 on the same plate being the latter, though not so indicated in the text on p. 320; while Fig. 5, pl. 32, is *Polyborus,* not *Ibycter,* as stated.

On the whole, Mr. Pycraft's paper is an excellent and most important contribution to a very interesting ornithological subject, and it is to be hoped that after extending his investigations to numerous forms not mentioned by him and therefore presumably not examined, he may finally give us the benefit of his studies in a more elaborate treatise.

ROBERT RIDGWAY.

U. S. NATIONAL MUSEUM,
December 11, 1902.

* My Geranospizæ included *Polyboroides,* a genus not mentioned by Pycraft.

† Whether Pycraft would include more than *Urubitinga* is uncertain. My group contained, in addition to that genus, *Buteogallus, Heterospizias,* and *Parabuteo* (*'Antenor'*), the last of which Pycraft places in his Buteoninæ, the other two not being mentioned by him.

‡ Pycraft's Buteoninæ includes *Archibuteo,* which I had placed by itself, *Parabuteo* (*'Antenor'*), which I placed in Urubitingæ, and *Busarellus,* which I put with Haliaeti.

§ My Haliaeti included *Thalassoaëtus, Haliaeëtus, Polioaëtus, Haliastur, Milvus,* and *Busarellus,* to which I would now add *Gypoictinia.* Pycraft's Milvinæ includes *Haliaeëtus, Polioaëtus, Haliastur,* and *Milvus,* to which are *very doubtfully* added *Ictinia* and *Rostrhamus.*

‖ My Aquilæ at first included, besides the genera comprising Pycraft's Aquilinæ, *Harpyhaliaëtus, Morphnus,* and *Thrasaëtus,* but in 1876 the last two were taken out and designated as a separate group, Morphni, exactly equivalent to Pycraft's Thrasaëtinæ. The correct position of *Harpyhaliaëtus* is, with me, a matter of doubt, but I am now inclined to the opinion that it should either go into the Urubitingæ or constitute a monotypic group.

¶ My Circaëti consisted of *Circaëtus, Spilornis,* and *Helotarsus;* Pycraft's of the first and last, the second not being mentioned by him.

** Consisting of *Archbuteo* only.

†† It would be interesting to know where Mr. Pycraft would place *Gypaëtus.*

ELEPHAS COLUMBI AND OTHER MAMMALS IN THE SWAMPS OF WHITMAN COUNTY, WASHINGTON.

ON the 27th of November, 1877, on my way down the Columbia River, from the Dalles, Oregon, I met an army surgeon who told me of a deposit of extinct animals, discovered the year before in 'mud-springs,' in the swamps of Pine Creek valley, Whitman County, Washington, about 100 miles north of Walla Walla. Mr. Copeland, in probing one of these springs on his farm with a long pole, thought the end entered the occipital foramen of a large skull. He had a long iron rod with grappling hooks at the end made. With this tool, and with the assistance of his neighbors he was able to dislodge and bring to the surface a very complete skull of the

mammoth. Continued labor recovered from the bed of gravel below a large part of the skeleton, all beautifully preserved. This aroused a great deal of excitement in that region. While the curiosity of the people was at white heat, a showman bought the skeleton for a thousand dollars, and put it under canvas for public exhibition. I afterward met this gentleman, who offered the specimen, securely packed for transportation at San Francisco, for a few hundred dollars. I wrote to Professor E. D. Cope, in whose employ I was, giving him all the particulars, and address of the possessor, whose name I have now forgotten. On the strength of the information given me by the surgeon, I resolved to conduct an expedition to the Pine Creek region. I left Fort Walla Walla sometime in January, 1878. At Moscow, Idaho, I secured the services of Joe Huff, who furnished a team and wagon. We pressed on through Colfax to Pine Creek (it heads in the high hills not far from where we came to it, at a stockade that had been built to protect the settlers from Indians a few years before; we made our permanent camp here), and spent most of our time until April, when we started for the John Day region, in eastern Oregon. The mouth of the spring we explored was only two feet above the creek. To add to our discomfort, it rained nearly every day; but with unfailing enthusiasm we bailed mud and water week after week. The larger we got the excavation, the more water to bail out. In enlarging the pit we found the walls of the spring were composed first of a thick bed of peat, then a stratum of compact yellow clay, then gravel, in which the bones were deposited, about twelve feet below the surface. In spite of our strenuous labors, we were only rewarded with the discovery of a number of fine skulls of the buffalo. In one we found a flint arrow-point and bones of the skeleton. The farmer-fossil-hunters had been more fortunate. The so-called 'mud-springs' in this region often cover acres of swamp land along the upper reaches of Pine Creek. They usually have a circular outline, and are full of thick mud; in wet weather they are in a state resembling ebullition. In very dry weather they are covered with a crust of dried mud that is cracked in all directions. These crusts not being strong enough to support much weight, they become death traps to the animals that attempt to cross them. Many of the farmers' animals were lost in them. On March 1, 1878, I met Mr. Copeland for the first time. He told me he had taken nine specimens of the mammoth from the swamp on his ranch. These, as I remember, he had deposited in a college in Forest Grove, Oregon. He discovered a flint spear-point in the gravel above the mammoth bones, associated with charred and partly petrified wood that bore the marks of tools upon it, also deer, buffalo and bird bones. On March 2 we went with Mr. Copeland to see the springs on the Donahue brothers' ranch up Pine Creek. Here the swamp covered seven or eight acres, and the owners had made large excavations. I was told they had recovered a large number of elephant remains. I found on the dump a few elephant bones, with those of the buffalo, deer, etc. I do not remember what became of the specimens discovered by these gentlemen. Although I did not actually find elephant bones mingled with the buffalo we found so common in our spring, I never doubted, from what I saw and heard at the other excavations in the immediate neighborhood, and where the collectors went through the same kind of peat, clay and gravel as we had gone through, that man, the buffalo, elephant and many existing species once lived together in eastern Washington. It seems to me these swamps should receive careful attention from paleontologists. A systematic series of explorations here may give valuable information of early man and the animals with whom he associated.

The skull of *Elephas Columbi* above referred to is now in the collection of the American Museum of Natural History, with other fossils of the Cope collection.

Charles H. Sternberg.

HERBARIA FORMATIONUM COLORADENSIUM; F. E. ET E. S. CLEMENTS.

One of the phases of botany now in active advance both in this country and abroad is

ecological plant-geography, or phytogeography, the study of the ecology of the vegetation of particular regions. It aims to elucidate the factors determining not only the adaptations of species (*vegetation forms*) to their habitats, but also their association into groups (*formations* [*societies*], *associations*, etc.) constituting the plant-life of any region, a subject of the greatest educational and popular, as well as scientific, interest. Such investigation is still so new as to exhibit many of the crudities of youth, and its methods and terminology are yet undifferentiated; but the field is attractive and promises rich results to a truly scientific attack. In this country there are three active centers of phytogeographical study, the universities of Nebraska, Chicago and Minnesota. Under the auspices of the botanical seminar of the University of Nebraska, Drs. Pound and Clements have published a volume, 'The Phytogeography of Nebraska' (Second ed., 1900) which represents the most extensive and thorough ecological study, from a scientific standpoint, of the vegetation of a particular region which has been attempted in this country. And now one of the authors, Dr. Clements, has taken the lead in a work of another kind which is likely to be much followed in the near future, namely, the preparation of sets of herbarium specimens, supplemented by photographs, to illustrate by these two most accurate of available methods the phytogeography of an important region in the Rocky Mountains, and he has placed a number of these sets at the disposal of other institutions and students.

This collection consists of herbarium specimens of standard size and most excellent preservation illustrating some 533 species of prominent Colorado mountain-plants, supplemented by 101 photographs 6 x 8 inches, the great majority of which leave nothing to be desired in the clearness of illustration of their subject and in artistic photographic excellence. They are selected to show either individual prominent plants (the vegetation forms), or associations of these (facies) or the larger groups occupying characteristic situations (formations), while a few illustrate special features of reforestation, etc. Equally important with specimens and photographs are the labels, of which a specimen taken at random reads thus:

HERBARIA FORMATIONUM COLORADENSIUM

F. E. et E. S. CLEMENTS.

93. *Gentiana affinis* Griseb.

Herba rhizomatica endemica, Minn-NM-Nev-BC., species principalis aspectus autumnalis Pinus ponderosa-flexilis-xero-hylio.
Crystal Park 2600 m. 4 Septembris 1901.

The labels thus give, in addition to the more usual information, a short characterization of the vegetation form and a mention of its place in a particular formation, *e. g., the Pinus ponderosa and flexilis dry forest.* The labels thus embody Dr. Clements's new proposals for phytogeographical nomenclature, an extremely carefully and judiciously elaborated system which the author has since published in Engler's 'Botanische Jahrbücher' (Beiblatt No. 70, 1902). His system consists essentially of the naming of formations by combining the genus (and species) names of the prominent vegetation forms with terms from Latin and Greek roots precisely descriptive of the habitats. It is of course yet too early to permit of any prediction as to how widely the system will be followed, but there can be no doubt that it is much the most serious attack upon this important problem that has yet been made, and not only must future workers take account of it, but it is very likely to form the foundation of the permanent system. In this admirable collection Dr. Clements thus characterizes some sixteen formations, and shows the place in each of the various vegetation forms, while a set of check-labels makes the classification easy and plain. When one examines these specimens in close comparison with the photographs, bringing the two into correlation by use of the labels, he has the means of obtaining the most accurate and vivid impression of the vegetation of this region that can possibly be obtained without an actual visit. For this reason it is altogether likely that the method will be extensively used in the future in the description and illustration of the phytogeography of the different regions of the earth, both as a means

of preserving phytogeographical data for convenient reference, and also for various educational purposes. In this Dr. Clements is the pioneer, and deserves our congratulations upon the success of this first attempt.

It is understood that twenty-four sets (the price of which was very moderate) were prepared, of which all or nearly all have been taken, about a third of them by institutions abroad.

W. F. Ganong.

NOTE ON NEGATIVE DIGITS.

In the common scale of notation 2873 stands for $2000+800+70+3$. The same number might be represented by $3\bar{1}\bar{3}3$ which is intended to mean $3000-100-30+3$. It might also be written $3\bar{1}2\bar{7}$ or $29\bar{3}3$, and, indeed, a great variety of ways might easily be found, but the form $3\bar{1}\bar{3}3$ is most advantageous in that the absolute values of the digits are the smallest possible. It is clear that any number may be written so that all its digits shall be less than six in absolute value. In fact, we may replace 9 by $1,\bar{8}$ by $\bar{2}$, 7 by $\bar{3}$ and 6 by $\bar{4}$, leaving the others unchanged. This amounts to replacing the digit K by $10-K$, so that we must add one unit to the adjacent digit on the left. We have then the following rules for changing any digit from plus to minus and from minus to plus:

1. *To change a digit from plus to minus, subtract it from* 10 *and add* 1 *to the digit on the left.*

2. *To change a digit from minus to plus, subtract it from* 10 *and subtract* 1 *from the digit on the left.*

In practice one begins on the right and changes successively those digits which are greater than 5. Thus to change 82755637 the 7 on the right goes into $\bar{3}$ and the 3 becomes a 4, the 6 changes to $\bar{4}$ and the 5 adjacent to it becomes 6, which goes into $\bar{4}$ and makes the second 5 a 6. This goes in turn into $\bar{4}$ and changes 7 to 8 or $\bar{2}$ and the 2 becomes 3. The last digit on the left becomes $\bar{2}$, which changes the digit next to it on the left (namely 0) to 1. The whole process then gives

$$1\ \bar{2}\ 3\ \bar{2}\ \bar{4}\ \bar{4}\ \bar{4}\ 4\ \bar{3}.$$

The reverse process is carried out similarly, and half an hour's practice will enable one to make the change from one notation to the other with little effort of the mind.

The new notation is of little value in addition or subtraction and is entirely useless in division. In multiplication its value, however, can hardly be overestimated. The advantage in using it is twofold. The digits are all less than 6 and there is twice the chance of repeated digits in the multiplier. Thus, in the ordinary method of multiplication, if one has obtained the partial product corresponding to a digit 3 in the multiplier, one obtains the partial product corresponding to a digit $\bar{3}$ by changing the signs of all the digits in the first partial product. In the short method of multiplication given in Science, July 11, 1902, it is difficult to deal with large digits. Thus, to find the product of 987593×86759 by that method would be a difficult and fatiguing task. Changing to negative digits, however, one finds the product can be written out with perfect ease, thus:

$$\begin{array}{r} 1\ 0\ 1\ \bar{2}\ 4\ \bar{1}\ 3 \\ 1\ \bar{1}\ \bar{3}\ 2\ \bar{4}\ \bar{1} \\ \hline 1\ \bar{1}\ 4\ \bar{3}\ 3\ 2\ 4\ 1\ 1\ 2 \\ 1\ 0\ 1\ 7\ \ \bar{1}\ \bar{1}\ \bar{3} \\ \hline 8\ 5\ 6\ 8\ 2\ 5\ 8\ 1\ 0\ 8\ 7 \end{array}$$

D. N. Lehmer.

University of California,
October, 1902.

MUSEUM NOTES.

Part X., Volume II., of the *Annals of the South African Museum* is devoted to a continuation of 'The Moths of South Africa,' by G. F. Hampson. The present instalment, comprising nearly two hundred pages, deals entirely with the large family Noctuidæ, and gives keys to the subfamilies, genera and species. The descriptions are very full and include a great number of new species; the greater number of types are in the British Museum, but the location of all others is noted.

Part II. of the *Memoirs of the Carnegie Museum* contains a detailed description of the osteology of 'Oligocene Canidæ,' by J. B. Hatcher, including *Daphnœus felinus, Pro-*

amphicyon nebrascensis and *Protemnocyon inflatus*, the last two genera and species being new. The author has a well-timed protest against the establishing of phylogenetic relations between species widely scattered in time and distribution. There is one feature about this memoir which demands special attention, and that is the date. This paper appears not to have been distributed until February, 1903, but the date on the cover is September, 1902, an apparent antedating of four months. Mere printing is not publication; an author may print descriptions of new species by the score and stack them away in the attic, but he can not, in such a case, be considered as having published descriptions of these species. In the present instance if, prior to February, 1903, John Smith had *published* descriptions of the two new species included in this memoir, he would justly be the author of those species in spite of the date on the cover of 'Oligocene Canidæ.' And yet the bibliographer, following the title, will credit them as September, 1902. In these days of multitudinous publications it is highly important that they should be correctly dated.

THE 'Report of the Public Museum of the City of Milwaukee' for the two years ending August 31, 1900, shows steady growth of the institution, while the list of accessions testifies to the interest of the citizens. The new custodian, Mr. Henry L. Ward, expresses his desire that the museum should become a prominent educational factor in Milwaukee, and various synoptical series have been commenced with this end in view. This particular province of a local museum is very apt to be neglected and the mistaken effort made to follow along the line of great and long-established museums. A strictly educational museum, unless it be the Children's Museum of the Brooklyn Institute, has not yet been attempted and there is a fine field open here for some one. As Mr. Ward says, it is easy to make such a collection so deep and technical and the labels so long that they are their own undoing, but we should like to see a museum started with the education of the average visitor considered at the outset.

F. A. L.

BEDELL COMPOSITE TRANSMISSIONS.

PROFESSOR FREDERICK BEDELL has, for some years past, been employing the electric light and power transmission lines in telephony, communicating freely wherever those lines extend. He has recently effected an important extension of his system of 'composite' transmission, utilizing a common system of distribution for both light and power transmission and for direct or alternating currents, the latter of any desired frequency. Lighting, requiring a high frequency, and power, demanding low frequencies, the one employing a single, the other a polyphase, system, may be obtained from the same system of distributing wires. The non-interference of asynchronous currents here finds its most valuable illustration. The earlier use of such simultaneous asynchronous currents in multiple-telegraphy and in Bedell's telephony is now carried to its limit by systems of composite transmission for light and power purposes.

The Bedell system includes various methods of simultaneous transmission of direct and alternating currents or of alternating currents of different frequencies. One method permits the transmission of such currents both in the high-tension primary mains and in the low-tension secondary circuits. This arrangement gives an advantage over usual dispositions in the fact that low frequencies in the polyphase circuit insures satisfactory performance of all synchronous machinery, with low line-inductance and improved regulation of e. m. f. and a perfect balance of loads on the different phases.

With this system the motor loads may fluctuate, even to the extent of operating the circuit-breakers on the polyphase generators and system, without affecting the lighting system. The two systems of transmission may be regulated separately and independently, and it becomes practicable to adopt a higher load for each than would be ordinarily permissible. The line drop on the lighting circuit may be compensated by compounding at the generator and the power system of distribution is not limited in its applications by the necessity of considering the working of the lighting system.

In low-tension secondary distribution, the direct current from the converter being introduced at the neutral points of the two distributing-circuit coils, the passage or interruption of the current thus introduced has no effect upon the action of the alternating system. A considerable variety of distribution, in detail, has been found practicable with this system, and the outcome of its adoption is expected to be a very considerable saving in cost of line and in expense of both light and power production.* It lends itself equally to distributions in light and power systems and to simultaneous operation of arc and incandescent lamps, giving a gain, often large, in the cost of copper and of line, and simplifying the whole scheme of transmission of electrical energy to multiple forms of work.

R. H. Thurston.

BRAIN-WEIGHTS OF BROTHERS AND SISTERS.

Brain-weights of brothers and sisters are not often obtained. When Professor Joseph Leidy and his brother, Dr. Philip Leidy, died within a few hours of each other, their brains, examined under similar circumstances and by the same observer (Professor Harrison Allen), were found to weigh exactly the same, 45.5 ounces troy weight, or 1,415 grams. The more distinguished of the two, Professor Joseph Leidy, was also fourteen years older than his brother. Marchand, in his recent work on brain-weights, cites some interesting figures from Professor Kockel, who had the opportunity to remove and weigh the brains of three brothers and of a brother and two sisters. The figures follow:

A. BROTHER AND TWO SISTERS, DROWNED TOGETHER.

Boy, age 4½ years	88 cm.	1292 gms.
Girl, age 3½ years	83 "	950 "
Girl, age 2 years	67 "	960 "

B. THREE BROTHERS, SUFFOCATED BY ILLUMINATING GAS.

Boy, age 12½ years	133 cm.	1400 gms.
Boy, age 8 years	121 "	1460 "
Boy, age 4¾ years	100 "	1400 "

* For descriptions of some of these features and of illustrative distributions see *Trans. M. E. and E. E. Assoc. of Cornell University*, February 2, 1903; *Elect. World and Engineer*, February 28, 1903; *Electrical Age*, March, 1903.

It may be noted in the first instance that the brain-weight of the two-year-old girl exceeds that of the older sister by 10 grams, while the brother's, who was only 5 cm. taller than the elder sister, exceeds her brain-weight by 342 grams. In the second instance the brain of the eight-year-old boy is 60 grams heavier than that of the older brother, while the latter's brain-weight is equaled by that of the youngest brother. It should be added that all three brains were exceedingly hyperæmic, the venous channels were filled with much blood, and the brain-substance generally was moist and soft. The brains of adult brothers and sisters are more desirable for comparison.

E. A. S.

*HARVARD METHOD OF TEACHING PHYSIOLOGY.**

The new method of teaching physiology proposed in the *Boston Medical and Surgical Journal*, December 29, 1898, and more fully explained in the *Philadelphia Medical Journal*, September 1, 1900, was adopted by the Harvard Medical School in 1899.

The traditional method of teaching physiology consists of a systematic course of lectures illustrated by occasional demonstrations. For thirty years or more, especially in England, this didactic teaching has been further illustrated by certain experiments performed by the students themselves. Laboratory experiments, therefore, have long been a valued part of the instruction in physiology in many universities. When the new method of teaching was introduced in the Harvard Medical School, and two hundred students worked daily in the physiological laboratories, it was said that this was only doing in a large way that which had been done in a small way for many years. The enterprise was held to be valuable because it showed that large numbers of first-year medical students could be carried simultaneously through a long series of experiments, many of which had been thought beyond their powers; it was a lesson in faith and an example of administration, but nothing more.

* From 'Physiology at Harvard,' by W. T. Porter, second edition, January, 1903.

It will be obvious that this criticism is based upon a misapprehension. The new method is not an extension of the old. It is a fundamentally different process. The old method is chiefly didactic. The new is a systematic course of experiment and observation by the student himself. In the old the student rests upon the dictum of the professor and the text-book. In the new he relies upon the fundamental experiments done with his own hands. In the old his experiments follow the lecture and attempt to verify its statements. In the new the lecture follows his experiments and discusses them in relation to the work of other observers. In the old the stress is upon the didactic teaching. In the new the stress is upon observation. Under the old method, students in the Harvard Medical School used to ask, 'Who is the authority for that statement?' Under the new, they ask, 'What is the experimental evidence?' The old method insensibly teaches men to depend upon authority, but the new directs them to nature.

In the old method the experiments performed by the students are almost exclusively such as are quickly and easily done; for example, the simpler experiments in the physiology of muscle and of the circulation of the blood. They are intended to illustrate physiological experimentation rather than to disclose step by step the groundwork of the science of physiology.

In the new method, on the contrary, the fundamental experiments and observations which form the solid ground in every field of physiology are divided into sufficiently small groups and arranged in the most instructive sequence. With the fundamental experiment of each group are placed the accessory data. The meaning of this term will be clear from the following example. Consider the function of the roots of spinal nerves. The fundamental experiment here is Johannes Müller's well-known section and stimulation of the nerve-roots. The accessory data are such of the observations and opinions of his successors as are necessary to give a clear picture of the present state of knowledge of this subject. The student makes for himself the fundamental observation, and immediately afterward considers the accessory data provided in text-book and lecture. He proceeds systematically from the fundamental experiment and accessory data of one group to those of the next, in an ordered and logical series.

The fundamental experiment and the accessory data are taken as directly as possible from the original sources, and the reference is given in each case.

It should be observed that this new method serves for the instruction of all students, from beginners to those engaged in research. The beginner performs the fundamental experiment in each group and studies the accessory data. The advanced student performs the fundamental experiments and as many of the accessory experiments as may give him the special training he desires. The research student has before him the classical observations and the original sources of the problem he has chosen.

It should be noticed also that the new need not violently push aside the old method of instruction, but may replace it chapter by chapter as the means and the energy of the instructors shall permit.

It has been urged against the new method that there are fundamental experiments which require more time than the student can possibly give, or which are too complicated to be successfully performed by him. The number of these has certainly been much exaggerated, and is daily lessened by inventions that secure simplicity without loss of accuracy. Pending such labor-saving inventions, the experiments which consume much time may well be done by committees of students, and the results reported to the entire class, who will compare them with the account given by the original discoverers.

SCIENTIFIC NOTES AND NEWS.

THE council of the British Association for the Advancement of Science has nominated the Right Hon. Arthur James Balfour to the office of president for the Cambridge meeting in 1904. They further agreed to recommend to the association the acceptance of the invitation to South Africa for the year 1905.

Professor Koch has been elected a foreign associate to the Paris Academy of Sciences in succession to the late Rudolf Virchow.

Sir David Gill, astronomer royal at the Cape, is to direct an expedition to complete the scientific survey of Rhodesia.

Dr. Hugh M. Smith, the newly appointed deputy commissioner of fish and fisheries, has left Washington for Japan, where he will make a series of investigations into the fisheries with reference to saving the terrapin industry of the United States.

Dr. L. A. Bauer returned to Washington from Porto Rico on March 16. A series of magnetic observations was successfully carried out on the Coast Survey steamer *Blake* on her trip from Baltimore to Porto Rico; a temporary magnetic observatory was put in operation on Vieques Island, to the east of Porto Rico and on the homeward trip *via* Havana, magnetic observations were obtained at two stations in Santo Domingo and at four in Cuba.

Dr. A. E. Ortmann, now of Princeton University, has accepted the position of curator of invertebrate zoology at the Carnegie Museum, Pittsburgh. He will assume the duties of his office on July 1, and asks that thereafter all correspondence be addressed accordingly.

At a meeting of the American Geographical Society in New York on March 17, the Cullum gold medal was awarded to the Duke of the Abruzzi in recognition of his services to geography by his ascent of Mount St. Elias in 1897, and his Arctic explorations in the region of Franz Josef Land in 1899–1900. The Duke of the Abruzzi is the sixth explorer to be thus honored by the society, the previous recipients of the medal having been Commander Peary, Dr. Nansen, Sir John Murray, Dr. T. C. Mendenhall and Dr. A. Donaldson Smith.

The University of Halle has conferred a gold medal on Professor J. P. Pawlow, of St. Petersburg, for his research on digestion.

As we have reported a gold medal was presented to Professor von Esmarch, the eminent surgeon, on the occasion of his recent birthday. Medical journals state that it is now proposed to give a bronze replica of the medal to persons or societies that have distinguished themselves in the first aid or Samaritan movement, as it is called in Germany. The first medal was presented to Prince Henry of Prussia, February 14.

The Medical Club of Philadelphia will give a reception to Dr. William Osler, of the Johns Hopkins Medical School, at the Hotel Bellevue on March 27.

Professor Ira N. Hollis, who holds the chair of engineering of Harvard University, has been elected president of the Boston Society of Civil Engineers.

Professor E. Mazelle has been appointed director of the Astronomical-meteorological Observatory at Triest.

Nature states that Dr. J. W. Gregory, F.R.S., professor of geology in the University of Melbourne, has met with an accident, necessitating an operation under chloroform. He was conducting scientific investigations in Tasmania at the time, and considerable anxiety has been felt concerning him. The latest news is, however, reassuring.

Dr. George F. Barker, emeritus professor of physics at the University of Pennsylvania, lectured before the Chemical Club of Columbia University on March 19, his subject being 'Radium.'

Sir Robert Ball began a course of three lectures at the Royal Institution on March 17, his subject being 'Great Problems in Astronomy.' Friday evening discourses are announced on the 20th by Professor E. A. Schäfer on the 'Paths of Volition,' on the 27th by Professor Herdman on the 'Pearl Fisheries of Ceylon,' and on April 3 by Lord Rayleigh on 'Drops and Surface Tension.'

It is proposed in Vienna to erect a monument to the African explorer, Dr. Holub, who died last year.

A committee representing Cambridge University and the Royal Society has been formed to secure a memorial of the late Sir George Gabriel Stokes.

THERE will be a civil service examination on May 1 for the position of systematic agrostologist in the Bureau of Plant Industry, Department of Agriculture, at a salary of $2,000. On April 21 there will be an examination to fill a number of vacancies in the position of aid in the U. S. Coast and Geodetic Survey, at a salary of $720 per annum. The age limit is eighteen to twenty-five years.

The collection of Diptera, especially Muscidæ, made by Dr. Garry de N. Hough, of New Bedford, has lately been acquired by the University of Chicago. It is believed to contain some 20,000 specimens.

THE will of Mrs. Susan Bevier gives $50,000 to the Rochester Athenæum and Mechanics' Institute. The income is to be devoted to the purchase of paintings and works of art, which are to be placed in the Bevier Memorial building.

THE Michigan Academy of Sciences will hold its spring meeting at Ann Arbor on March 26, 27 and 28. There will be sections in (1) agriculture, (2) botany, (3) zoology, (4) geography and geology, (5) sanitary science and (6) science teaching.

THE announcement of the Ohio State University Lake Laboratory, at Sandusky indicates increased facilities in the provision of a commodious laboratory building capable of accommodating at least one hundred students and investigators. Courses are offered in zoology, botany, entomology, ornithology and physiology, with opportunities for research work or independent investigation. The latter with no charge for use of tables and general laboratory facilities. During the last summer's session twenty-four students and investigators were enrolled, these representing fourteen different colleges and universities. A series of general lectures included the following topics: 'Physiographic Features of Sandusky Region,' by Profesor E. L. Moseley; 'The Harriman Alaskan Expedition,' by Mr. Leon J. Cole, of the U. S. Fish Commission; 'The Biological Features of the Florida Keys,' by Professor E. L. Morris, of the U. S. Department of Agriculture; 'Adaptation in Animal Life,' by the director; 'Evolution of Plants in Time,' by Professor J. H. Schaffner; 'Collecting in the Philippine Islands,' by Professor E. L. Moseley. The session for 1903 opens on June 29, and lasts six weeks, while the privileges of the laboratory are open to both students and investigators for at least two weeks longer for independent work. Announcements giving details may be obtained by addressing the director, Professor Herbert Osborn, Ohio State University, Columbus, Ohio.

THE Biological Laboratory of the Brooklyn Institute of Arts and Sciences, located at Cold Spring Harbor, Long Island, will hold its next regular session for six weeks beginning Wednesday, July 1. Courses are offered in high school zoology by Dr. Davenport and Mr. Lutz, in comparative anatomy by Dr. Pratt, in invertebrate embryology by Dr. Sigerfoos, in animal bionomics and variation by Dr. Davenport, in cryptogamic botany by Dr. Johnson, in ecology by Mr. Whitford, in bacteriology by Dr. Davis, and in microscopic methods by Mrs. Davenport. Fifty students are admitted to receive instruction, the tuition fee being $25. A limited number of rooms are offered free of rental to properly qualified investigators. Application for such rooms or for further information may be made to Professor C. B. Davenport, University of Chicago.

HARVARD UNIVERSITY offers a summer course of five weeks in geological field-work in the Rocky mountain region, beginning about the first of July. The field selected includes the higher groups of mountains in southwestern Colorado. The course will be in charge of Mr. Chas. H. White, who will send a descriptive circular on application, giving dates, outfit, expenses, etc. Mr. White's address is Rotch Building, Harvard University, Cambridge, Mass.

UNIVERSITY AND EDUCATIONAL NEWS.

PURDUE UNIVERSITY has recently been the recipient of liberal treatment at the hands of its state legislature, just adjourned. By an amendment to a previously existing law,

the income of the university has been increased from a twentieth of a mill to a tenth of a mill upon the assessed value of the state. The increase is about $65,000, which brings the university's annual income from all sources considerably above $200,000. The legislature, also, made specific appropriations amounting in round numbers to $150,000, out of which is to be provided a central heating plant and a building for the department of physics.

The daily papers publish the following letter from Mr. Andrew Carnegie to the president of Cornell University: "I have followed with anxious interest your sad plight regarding pure water. To-day I read with relief that Cornell has contracted for a filtering plant of its own. If the trustees would permit me to pay for it I shall be very grateful indeed."

Harvard University will erect as a gift from the class of 1879 and from the accumulations of athletic funds a stadium. It will cost $175,000 and seat 30,000 people.

Mr. John D. Rockefeller has offered to give Denison College, Newark, Ohio, $60,000, if the institution will raise a like sum by January 1, 1904, for the construction of additional buildings.

Dr. Elizabeth L. McMahon, Marion, Ohio, in her will, which has recently been filed for probate, left $8,000 to found a scholarship in Vassar College for daughters of deceased physicians.

Colby University, Maine, receives $5,000 by the will of the late Robert O. Fuller, of Cambridge, Mass.

The University of Toronto has received subscriptions amounting to $30,000 toward a convocation hall, of which sum Mr. Chester Macy has given $5,000, and Professor and Mrs. Goldwin Smith $2,000.

Mr. David Davies, of Llandinam, has presented the University College of Wales, Aberystwyth, £20,000.

The Council of University College, London, has resolved to institute a new grade of lecturers analogous to that of *Privatdocent* of German universities.

William J. Moenkhaus, assistant professor of zoology at Indiana University, known from his papers on variation in fishes, received the degree of Doctor of Philosophy at the recent convocation of the University of Chicago. The subject of his thesis is: 'The development of the hybrids between *Fundulus heteroclitus* and *Menidia notata* with especial reference to the behavior of the maternal and paternal chromatin.'

Professor Joseph Barrell, Ph.D., head of the Department of Geology in Lehigh University, has accepted a position as assistant professor of structural geology in Yale University.

The following appointments have been announced at the Massachusetts Institute of Technology: Mr. Leonard D. P. Dickinson, as assistant in electrical engineering; Mr. H. B. Litchman and Mr. Frederic W. Snow, as assistants in mining engineering and metallurgy; Mr. J. Lloyd Wayne, as assistant in mechanical engineering; Mr. Gragg Richards, as assistant in geology; Mr. Robert V. Brown, as assistant in inorganic chemistry, and Mr. George E. Bradley, as assistant in metal work.

The Isaac Newton studentship, at Cambridge University, for the encouragement of research in astronomy, of the value of £200, has been awarded to C. M. Cama, B.A., of St. John's College, sixth wrangler, 1901. The Smith's prizemen this year are Mr. H. Knapman, Emmanuel, second wrangler 1901, and Mr. A. P. Thompson, Pembroke, fifth wrangler 1901. Mr. W. H. Jackson, Clare, bracketed third wrangler 1901, receives honorable mention.

Miss Constance Jones, vice-mistress and lecturer in moral science at Girton College, Cambridge, has been appointed to be mistress of the college in succession to Miss Welsh, resigned. Miss Jones has published a translation of Lotze's 'Mikrokosmus,' and has lately been engaged in editing the unpublished ethical lectures of the late Professor Sidgwick.

Professor James Sully has resigned the Grote chair of philosophy of mind and logic at University College, London.